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A Quarterly Magazine
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Ornithology

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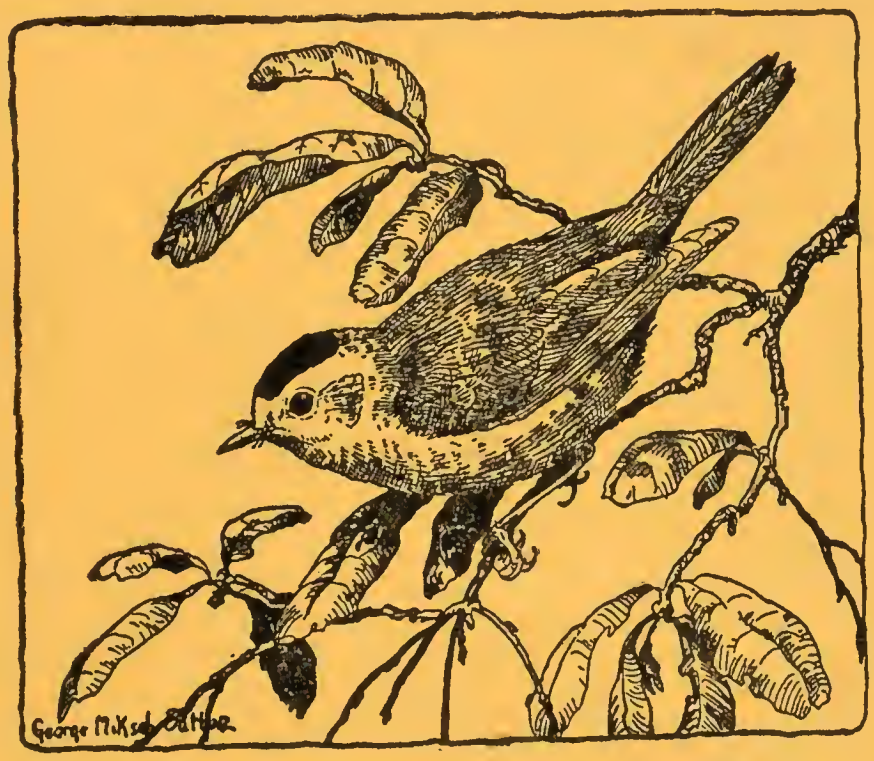

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BLACK-THROATED TROGON (*Trogon rufus*)

Male (top) and female. From a tempera painting by Don R. Eckelberry.

LIFE HISTORY OF THE BLACK-THROATED TROGON

BY ALEXANDER F. SKUTCH

On Barro Colorado Island in Gatún Lake, in the middle of the Isthmus of Panamá, I found my first two nests of the Black-throated Trogon (*Trogon rufus*), in 1935. Both were destroyed by predators before the eggs hatched. Four years later, in the Valley of El General in southern Costa Rica, I found my third nest, which met a similar fate. In most of the succeeding years I have studied birds in the same region, where these trogons are not uncommon, and I have encountered five additional nests. With the exception of one which I did not see until the young were almost feathered, only the last was successful. This was situated on our farm in El General in April, 1958, and enabled me to round out a study begun 23 years earlier. The present paper is, then, a report of observations gathered over nearly a quarter of a century. The slowness of their accumulation is to be attributed to the difficulty of finding the nests of the majority of the birds that dwell in tropical rain-forest, and the discouragingly small proportion of these nests that yield living young.

Appearance and Range

One of the smaller members of its family, the Black-throated Trogon has a total length of about nine inches, of which well over half is accounted for by its long tail. The male's predominant color is bright metallic green, which covers all the upper surface of head and body and likewise the chest. Golden reflections play over his glossy back. His lores, cheeks, chin, and throat are black; his lower breast, abdomen, and under tail-coverts bright orange-yellow. His central tail feathers are bluish-green with black tips, the outer ones white with narrow black bars. His wing-coverts are finely vermiculated with black and white, so that at a distance they appear gray, while the primaries are largely black. Each large, deep brown eye is surrounded by a prominent ring of pale blue, naked skin. His bill, waxy yellow when viewed in the sunshine, is of a tint so pale that in the shade it appears white. His short legs and toes are blackish. On head and body the female is mostly brown, with yellow on her lower breast, abdomen, and under tail-coverts. Her black-tipped central tail feathers are cinnamon-rufous, of a shade far brighter than her back; while the outer ones are white, narrowly barred with black. A wide white crescent behind and a narrower one in front of each dark brown eye give her an appearance of alertness. Her bill is gray, with black on the culmen and tip of the upper mandible, and her feet are dark. (The colors of the featherless parts are taken from notes made at nests on Barro Colorado Island and in El General.)

This lovely trogon ranges from eastern Honduras through southern Central America to the Guianas and Brazil. It inhabits not only the rain-forests of the Caribbean lowlands of Central America but also the drier and more open woodlands of the Pacific side north of the Gulf of Nicoya. In the rain-forests of El General, on the Pacific slope south of the Gulf of Nicoya, it is resident and breeds up to about 2500 feet above sea level; I can find no definite record of its presence anywhere much higher than this. I did not once meet it in the course of a year and a half of intensive bird-watching on the northern side of the basin of El General around 3000 feet. At this altitude it is replaced by the Collared Trogon (*Trogon collaris*), and in this region the two species appear not to overlap vertically.

Habitat and Food

I have most often met the Black-throated Trogon perching solitary in the heavy forest, well above my head but far below the crowns of the great trees. Rarely another adult was in view. Of the four trogons on our farm—the others being the Massena Trogon (*T. massena*), the Violaceous Trogon (*T. violaceus*), and the White-tailed or Baird's Trogon (*T. viridis*)—the Black-throated stays lowest. Although the other three sometimes wander and even nest outside the forest, in pastures and plantations with scattered trees, this shade-loving species seems never to venture beyond the shelter of continuous woodland. Like other members of its family, it perches very upright, with its tail pointing almost straight downward. It remains long in one spot, then suddenly darts out, plucks an insect from the foliage while hovering on wing, and carries it to the same or another perch to eat it. It sometimes takes berries or other small fruits in the same spectacular fashion; but it eats fewer of them than some of the other trogons, as I judge by the absence from its nest of the regurgitated seeds that accumulate abundantly in the chambers of the White-tailed Trogon, the Massena Trogon, the Quetzal (*Pharomachrus mocino*), and other species.

Voice

The call of the Black-throated Trogon consists of low, weak, mellow notes delivered in series of two, three, or less often four: *cow cow*, or *cow cow cow*, that of the female even weaker than that of the male. Of the associated trogons of the Central American lowlands, the Black-throated most resembles in voice the Violaceous Trogon, whose notes are of the same character but more forceful, and delivered more rapidly in longer series, perhaps a dozen together—a performance far more vigorous and spirited than that of the Black-throat. The call of the White-tailed Trogon, which also consists of soft, melodious notes, is easily distinguished by their acceleration and rise in pitch as the long series

proceeds, to end in a sort of roll. The voices of the Massena Trogon and the Citreoline Trogon, (*Trogon citreolus*) stronger and harsher than those of the foregoing species, are not readily confused with them. The Black-throated Trogon's call closely resembles that of its highland representative, the Collared Trogon, and to a less degree that of the Mexican Trogon (*T. mexicanus*).

When alarmed, or when cautiously approaching their nest, Black-throated Trogons of both sexes voice low churring and rattling notes, which sound something like *krrrr, krrr-ret, or krrr-re-ek.* As it utters these notes, the bird rather slowly raises its tail until it stands almost upright, then lowers it at about the same speed—a movement which makes the black-barred, white under surface of the tail flash out conspicuously.

A less frequent utterance consists of low, clear, beautifully modulated notes, mingled with the subdued, melancholy *cow*'s grouped in twos and threes, which I heard once in June from a male who perched in sight of my blind.

The male Black-throated Trogon presents the unexpected contrast of glittering plumage, which one associates with such active, spirited birds as hummingbirds and jacamars, and calm, subdued demeanor, expressed by dignified upright carriage, long motionless perching, and low, shrinking, almost melancholy notes sparsely used.

The Nest

In the sunny month of January, as the dry season becomes well established in El General, all the trogons in its forests call with increased frequency. Sometimes two male Black-throated Trogons call against each other, but even in rivalry their notes are low and subdued. Occasionally one dashes toward his opponent, who avoids contact by retreating. I have never seen trogons fight. As with nearly all the forest birds, I have not succeeded in learning how territories are delimited and pairs formed.

The cavities used for nesting are carved into decaying wood by both sexes. In El General, I found a pair beginning to excavate a hole as early as February 11, but the work proceeded slowly, with long intervals of neglect, and was not finished until about the end of March; it was April 10 before I found an egg in the hole. All the nests that I have seen have been dug into slender, upright stubs of dicotyledonous trees far advanced in decay, or in one instance in a dead part of the trunk of a small living tree. Often the trunk is so weak that in studying the nest one must take great care not to cause its collapse. My eight nests ranged from 4 feet 4 inches to 12 feet above the ground. Half of them were between 5 and 8 feet. The lowest was almost 3 feet below the top of a stump 7 feet high and 6 inches in diameter. The Black-throated Trogon appears consistently to avoid massive dead trunks such as are chosen by White-tailed Trogons and Massena Trogons for their more deeply carved chambers.

The Black-throated Trogon's nest cavity is hardly more than a shallow niche, with most of the front open. The opening is usually roughly pear-shaped, widest near the bottom, but exceptionally widest at about mid-height, and usually its outline is rather irregular. Often the edges are jagged. The five doorways of which I have measurements ranged from 4½ to 6½ inches in height and from 2½ to 2¾ inches in greatest width. The excavations extended from 1¼ to 2¾ inches below the lowest part of the opening, but most were more than 2 inches deep. The transverse diameter of these little hollows ranged from 3 to 4 inches; usually it was about 3½ inches. In this shallow depression the eggs rest and the nestlings grow up. The back and sides of the cavity slope forward and inward to meet the narrow top of the doorway, so that the whole niche is 6½ to 8 inches high. This upward extension of the excavation provides a place for the parents' long tails, which are turned upward and slightly forward above their backs as they incubate and brood. One exceptional nest, situated at the very top of a slender stump 12 feet high, had the usual entrance in the side, but this was confluent with an opening in the top of the stub, so that the eggs were exposed to the sky.

No lining is ever taken into this roughly carved chamber in a rotten trunk, but the eggs rest upon the few particles of loosened wood which remain on the bottom.

The Eggs

Of my eight nests, one had, when found, a single egg, which disappeared within two days; probably it was freshly laid and would have been followed by another if the nest had not been pillaged. Each of the remaining seven nests (five in El General and two on Barro Colorado) contained two eggs or nestlings, and this is the number found in two additional nests reported from Barro Colorado by Eisenmann (1952:28). Carriker (1910:559) also found a nest with two eggs at El Pozo de Térraba in southwestern Costa Rica. One of my nests contained a single egg when found, soon after midday on May 29, and the second was laid between 1:45 p.m. on May 30 and 10:45 a.m. on May 31. In another nest, the second egg was laid between 9:00 a.m. and 5:15 p.m. of the same day.

The eggs are bluntly ovate and white, with slight gloss. The measurements of seven average 27.6 by 22.0 mm. Those showing the four extremes measured *29.4* by 23.0, *26.2* by *23.8*, and 27.0 by *20.2* mm.

In El General, two nests from which the nestlings left on May 2 probably contained an egg at the very end of March. In two other nests eggs were laid in April, and in two, in May. In one of these the set was not complete until May 31. My two nests on Barro Colorado contained eggs when found in early April. For this locality Eisenmann records another nest with eggs in April, and one in which a nestling hatched about June 21. Carriker's nest at El Pozo

de Térraba contained eggs on June 21. Thus, the few available records indicate that in southern Central America the Black-throated Trogon begins to lay at the end of March, while the latest nestlings are fledged in early July.

Incubation

At noon on April 8, 1935, I entered a blind in front of my first nest on Barro Colorado Island, without disturbing the male trogon, who was then covering the two eggs. As we sat quietly through the afternoon, I could see his head rising just above the rounded bottom of the opening in the tottering stub, and sometimes the brilliant green feathers of his neck were ruffled over the rim. For hours he sat almost motionless; but the monotony of the long watch was broken when a Blue-crowned Wood-Nymph Hummingbird (*Thalurania furcata*), and then a Dusky-capped Flycatcher (*Myiarchus tuberculifer*), sunned themselves in a patch of brilliant sunshine that found its way through the forest canopy to fall upon a prostrate trunk just outside my right window, both in the same spot and attitude, lying flat with spread wings and outfluffed plumage. Later, when the sun was low, a band of seven collared peccaries (*Pecari tajacu*) walked in single file in front of the blind. Soon after their passage, the male trogon began to call in an undertone from the nest, a low, mellow *cow cow cow*, repeated again and again. After three minutes I heard the soft call of his mate. Then he started to leave the nest, but paused resting on the rim of the aperture. After a minute or so in this position, he darted out and promptly vanished among the trees. Then his mate went at once to the nest and clung upright in front of the doorway while she scrutinized her surroundings. After a brief survey, she climbed inside, turned around, and settled on the eggs, facing outward. This was at 5:26 p.m. Here she remained until, by 6:45, I could no longer see her and I stole away in the dusk.

At 6:00 the next morning, when the light was still dim in the woodland, I resumed my watch. Despite the slowly increasing light, I failed to see the trogon in the nest, and I began to fear that she had been frightened away in the night. But she was only sitting very low, perhaps still sleeping, for when the light grew stronger her head became visible above the doorsill. Nothing noteworthy happened until 9:09, when the female called *cow cow cow* in a low voice and the male called with similar notes from among the trees. After they had exchanged a number of calls, the female moved forward to rest in the doorway with much of her yellow belly showing outside. For several minutes she delayed here while she and her mate called back and forth. Finally, at 9:13, she flew away; and after the usual survey made while clinging upright before the entrance, the male went in at 9:19 and turned around to settle in the nest facing outward—the usual position. He sat steadily until I ended by watch at noon, and he was still present at 3:45 and 4:20 in the afternoon. Thus in the course of 24 hours the female had taken one long session, from 5:26 in the evening until 9:13 the next morning, and the male had incubated all the rest of the time.

On April 15, 1958, I made, with my wife's help, an all-day record at a nest with two eggs, in the forest near our house in El General. At 5:35 a.m. I entered the blind in the dusky underwood, and as it grew light I detected the white crescents before and behind the eyes of the sitting female, then gradually the rest of her head. At a little before 7:00, the male arrived and called with churring and rattling notes, *krrr-rek* and *krrr-re-ek*, several times repeated. Then he changed to a low *cow cow cow* as his mate very slowly pushed forward into the doorway, looking around as she did so. At 7:01 she darted off, and two minutes later the male entered. Although he stayed continuously at his post through the morning and early afternoon, he sat rather restlessly, frequently rising up to lower his head into the bottom of the cavity. He did this by turning sideways in the niche or even completely around, until his yellow belly filled the lower part of the doorway,

while his black-barred, white outer tail feathers occupied its upper portion, or sometimes projected slightly outside. He then seemed to be standing on his head, and his reversed position apparently made it easier for him to reach the eggs in the narrow niche; but whether he turned or merely examined them, I could not see. He would maintain this posture for a minute or two, rarely longer, then settle down in his usual position, head outward, eyes and bill just above the lower edge of the doorway, tail ascending above his back against the outward-sloping rear wall of the niche. If his tail had been just a little longer, it would have projected through the opening into the outer air, as happens with the far longer feathers of the male Quetzal's train.

At 2:34 p.m., when the sky was darkly overcast, a Violaceous Trogon called *cow cow cow cow cow* . . . . loudly overhead, and this apparently stimulated the Black-throated Trogon to call in his lower notes from the nest, where he had been sitting all day. After more calling while he rested on the doorsill, he flew to a neighboring branch and continued his *cow cow cow*. From 2:38 to 3:23 the eggs remained unattended, while rain began to fall. At 3:23 the female, after repeating a long, low rattle over and over, raising her tail above her back each time she did so, entered to resume incubation. Soon after 4:00 the shower stopped and the sun began to penetrate the clouds. I was certain that the female, sitting quietly, had settled down for the night; but, to my great surprise, the male returned at 5:03, apparently called her out, and at 5:08 went to the doorway, lowered his head as though to feed nestlings, then entered to incubate. He remained there only 17 minutes, for at 5:25 the female came back and resumed incubation. As the light grew dim, and she became invisible, I left.

The male had sat continuously for 7 hours 35 minutes, and again for 17 minutes late in the afternoon. Not counting the few minutes the eggs were left uncovered whenever the parents changed over, they were unattended for only one period of 45 minutes in the course of the day. The female sat all the rest of the day, and through the night. Except for the male's short session late in the afternoon, this pair had followed the pattern of incubation that I had found to be typical of the lowland trogons: two change-overs in each period of 24 hours, the male sitting for six to eight hours in one long stretch each day and the female the remainder of the time—a schedule which closely resembles that of incubating pigeons and doves.

The male's brief evening session seemed pointless in a bird that incubates for hours at a stretch, and I resolved to watch again to learn whether it was habitual with him. My first opportunity came two days later, when I entered the blind at 4:30 on a darkly clouded afternoon, while the female was sitting. I did not have long to wait for the male, who arrived at 4:42, and after seven minutes of *krrr*-ing and *cow*-ing finally persuaded his mate to make way for him. Then he promptly went to the nest, holding in his bill some small object that I could barely discern in the dim light. Clinging in front of the doorway, he lowered his head into the hollow as though feeding nestlings. After a while he entered, still holding the morsel, but presently he rose up, turned around until his yellow belly was in the doorway and his tail stuck up into the air, and seemed to be offering the food again. Soon he settled down in the usual incubating posture, still with food in his bill. In 14 minutes his mate returned and repeated her rattling call until, after five minutes, he gave up the nest to her. As well as I could see, he swallowed the morsel while she called. I could detect nothing in her bill, nor did she lower her head into the nest as though offering food to nestlings. After she had settled down, I put her off to see whether perchance a

nestling had hatched since my last inspection, but two eggs were reflected in the mirror that I held over the doorway. By 10:40 the following morning (April 18), however, one had hatched.

The male's proffer of food to unhatched eggs was not unprecedented in my experience, and elsewhere (Skutch, 1953:10–17) I have given a number of examples of such "anticipatory food-bringing." Possibly, even as early as our all-day watch on April 15, three days before hatching, the male had heard the tapping or weak calls of the imprisoned chicks making their first feeble attempts to break out of their shells. Perhaps this was responsible for his frequent turning in the nest, standing on his head, and inspecting the eggs beneath him. His return late in the afternoon of April 17 was evidently to attend chicks rather than to incubate eggs; and probably this was true of his similar return two days earlier, although I did not then notice—or look for—food in his bill. The female gave no indication that she was aware that the eggs were about to hatch; in my experience, female birds anticipate the nestlings less often than males.

In addition to the two long watches, I have records of 72 visits, at various times of day, to nests containing eggs. The latest hour of the morning at which I ever saw a female covering eggs was 11:25, at one of the nests on Barro Colorado, but it is most unusual to find her present after 9:00. The earliest hour at which I found a male in the nest was 7:00. My latest record of the presence of a male is 5:26 p.m., and my earliest of the female's afternoon return is 3:00 p.m. When the female continues to incubate as late as 11:00, her mate may have come to replace her so early in the morning that she would not relinquish the nest to him, and he went off and stayed away a long while. At least, I have seen this happen in the Collared Trogon (Skutch, 1956:359–360).

Black-throated Trogons sit closely and have remained on their eggs watching me set up a blind eight or ten yards in front of them, an operation which often involves much movement and noisy clearing away of undergrowth. Frequently, too, I have been able to enter or leave a blind, or to remove it, without chasing away the incubating male or female. But the fact that they sit steadfastly while one sets up a blind does not mean that they would enter the nest if one watched without concealment. Perhaps they remain firm in the presence of an intruder because their departure would betray the location of their nest if he had not already noticed it; and for the same reason, they hesitate to approach the nest if a man or other animal capable of harming it is in view.

At the nest which I discovered when newly begun on February 11, 1942, I did not see an egg until April 10. I had not visited the nest the preceding day, so it might well have been laid earlier. The second egg was deposited on April 11. One egg vanished in the course of incubation. The remaining one was

chipped in the afternoon of April 27 but did not hatch until two days later, on April 29. Thus the incubation period was at least 18 days, and possibly a little longer if the surviving egg was the first rather than the second of the set. This may be compared with the Mexican Trogon's incubation period of 18 or 19 days (Skutch, 1942).

The Nestlings

The newly hatched trogon has pink skin devoid of all down or visible rudiments of feathers, and its eyes are tightly closed. The pin feathers grow out rapidly, and when six days old the nestling bristles with them. By the tenth day they have become so long that they almost cover the nestling's upper parts; except for a few feather-tips, the plumage is still tightly ensheathed. But 24 hours later, at the age of 11 days, the nestling is fairly well clothed with freshly expanded plumage. The rectrices, however, are still wholly enclosed in their sheaths, and this is also true of many of the feathers of the crown. A day later the plumage of the crown has expanded and the rectrices are escaping their sheaths. When 13 days old, the young trogon is completely feathered on head, upper parts, and breast. Except for the large roundish spots on the wing-coverts and the buffy-brown rather than yellow of the abdomen, it rather closely resembles its mother in its rich brown attire. Like her, it has prominent white crescents behind and in front of each eye; these are joined by a narrower rim of white above and below the orbit, but on her the crescents are not confluent. Its bill is dark gray with lighter base and tip, and the feet flesh colored. A day or two later, at the age of 14 or 15 days, the young trogon leaves the nest.

On April 19, 1958, I watched from 6:30 to 11:30 a.m. at the nest in which the two nestlings had hatched on the preceding day. They were brooded constantly by both parents sitting alternately, except for the brief intervals taken up by the change-over and the delivery of food. The male, who was in the nest, when I arrived, sat for 3 periods of 49, 79, and 120 minutes, making a total of 248 minutes. The female brooded only twice, for 17 and then 7 minutes, or a total of 24 minutes. The remainder of the 5 hours, 28 minutes in all, was occupied by change-overs and the slow process of feeding the nestlings.

On its arrival to replace its mate on the nestlings, each of the parents behaved much as it did when it came for its turn at incubation, calling with either soft notes or churrs and rattles, or with a combination of the two. This was continued for several minutes, until at last the brooding partner bestirred itself and slowly left the nest, sometimes after calling softly in answer to the other. Each time that a parent returned it brought an insect or some unrecognizable object of food, usually small and green. Once the female came with a winged insect surprisingly large as a meal for a day-old nestling. After the departure of

its mate, the newly-arrived parent would cling upright in front of the doorway, its tail pressed against the trunk and head lowered into the cavity, and would patiently deliver the morsel. This usually took about two to four minutes, although eight minutes were occupied by the female in giving the very large insect to a nestling. The meal over, the parent climbed through the doorway and turned around to brood facing outward, just as it had incubated. In the five hours the two nestlings were fed as many times, twice by the male and thrice by the female, who brought a meal at the very end of this period. Since, as far as I could see, a parent brought only one article at a time, the most equitable division would have given no more than three insects to one nestling and two to the other.

On April 24, when the two nestlings were six days old, I again watched from 6:30 to 11:30 a.m. The morning was cloudy and cool, but the still featherless youngsters were left exposed nearly as much as they were covered. The female brooded twice, for 35 and later for 32 minutes, the male, only once, for a long session which had lasted 96 minutes when I went away and left him sitting. The female brought two green insects, which had been well mashed, but were so big that the nestlings, doubtless cold and sluggish from long exposure, did not succeed in swallowing them. Finally she ate them herself, twisting her head and neck from side to side as she forced the larger one down with an effort. The male brought three morsels, all of which the youngsters seemed to eat. The parents evidently did most of their hunting well up in the trees, for each time that they came I first heard their voices from above me, before they dropped to a perch in sight of the blind.

I next watched at this nest from 6:30 to 11:30 a.m. on April 29, when the two youngsters were 11 days old. On this sunny morning they were not brooded at all. The male came seven times with as many insects, most of which were very large and green, although one was brown. As formerly, to deliver a meal he clung upright before the doorway, his tail usually spread just enough to reveal a little of the white outer feathers with their black bars. But now he did not have to bend his head into the cavity, for with a loud sizzling noise the nestlings reached up well above the lower edge of the doorway to take their meals. One of them once spent about two minutes forcing down the large insect it had received.

Not having glimpsed the female during the morning, I watched for her again in the evening. The youngsters now rested with their heads visible in the doorway. The male brought them two more meals between 4:30 and 5:30, making nine feedings in six hours that day. The female did not arrive until 5:45, when the light was failing beneath the lofty trees. After calling *cow cow* very softly several times, then *krrr-re-e-e-e*, with the notes more widely spaced toward the end, she flew to the nest and clung in front of it; but I was not sure that she delivered food. Then she entered to brood, sitting very high in the cavity, with much of her yellow ventral plumage showing above the lower edge of the doorway, not merely her head as while she incubated the eggs. Here she stayed until I left in the dusk. This was the last time I saw her. If I had not watched for her to come and brood her nestlings that night, I should have inferred from her failure to feed them on that and later days that some accident had befallen her.

When I entered the blind at 12:20 p.m. on May 1, both of the nestlings, now well feathered, were looking through their doorway. Their white eye rings made them appear bright and alert. In the next four hours the male came 11 times, bringing 11 insects, some so large that the youngsters with difficulty forced them down. For half an hour rain fell

rather hard, but neither parent brooded the nestlings. Neither came to cover them at nightfall.

Next morning, May 2, I resumed my watch as it grew light. The male first brought food at 5:43, and by 6:00 he had given the nestlings four meals, after which he came more seldom. At about half-past six, a nestling rested with its breast against the lower edge of the doorway. Soon it grew restless, preened, and stretched its wings. Then for a while it drowsed with closed eyes, to be aroused when the male arrived with more food. After this meal, at 8:14, the nestling jumped up to perch on the doorsill—the first time I saw it there. It now began to utter rhythmically a low, soft note, which I could hardly hear above the voices of the cicadas. It preened, then drowsed. After a while, the other nestling tried to push its head through the doorway beside it.

At 9:04 the male flew up with an insect in his bill, alighted on a low branch about 20 feet from the nest, and churred as usual. The nestling thereupon flew from the doorway toward him, going well for a few yards, but falling when it tried to alight on a twig. The male darted toward it as it fluttered to the ground close in front of the blind. Here it rested behind a fallen palm frond and continued to utter the low, soft note at intervals of a few seconds; the male, perching low and still holding the insect he had brought, voiced alternately churrs and soft *cow*'s. Soon the youngster flew again, rising a few feet but dropping to the ground about five yards from its starting point. Presently it was out of sight, and, although I heard its low notes for nearly half an hour more, I never saw it again. Only 14 days old, it seemed small and weak to face the perils of the tropical forest.

The youngster in the nest, not the one who had just flown out, was given the insect which the male had. The stay-at-home also received the next meal, an insect so large that six minutes were required to gulp it down. But the male perched low and called softly many times, as though encouraging the fledgling to rise from the ground. After this feeding, at 9:40, he remained away from the nest for four hours, no doubt attending the youngster who had now wandered beyond my sight and hearing. From 1:40 to 4:15 observations were suspended; but at the latter hour the second nestling was still in the nest, with the male close by. Soon the young trogon began to utter soft monosyllables such as the other had voiced just before it flew; and until it left it kept up this utterance much of the time, now louder and now softer, at a rate varying from 24 to 28 notes per minute. As with closed bill it delivered each note, its throat swelled out conspicuously, and often it was easier to count the movements of the throat than the low notes themselves. At its loudest, however, the nestling's call resembled the soft *cow* of the parents and was not difficult to hear. When taking food it made the usual sizzling sound, but it might resume the rhythmic monosyllables even with a partly swallowed insect protruding from a corner of its mouth. In little over an hour that afternoon (4:40 to 5:44), the male brought seven meals to the nestling, which had evidently become very hungry after a long period of neglect. Sometimes it jumped up high in the nest in its cagerness for nourishment.

Next morning we watched from daybreak to 12:15 p.m., hoping to see the other young trogon depart. Before sunrise it began its monotonous calling, ceasing briefly while a squirrel passed close by the nest. Later, when the great dry frond of a chonta palm (*Iriartea*) crashed down loudly close by, it crouched in the bottom of the nest and remained silent for about 20 minutes. But it was calling loudly and persistently when the male arrived with the first meal of the day at 7:27, two hours after daybreak. By 9:02 it had been fed four times and was feeling strong enough to flap its wings and preen vigorously. Then followed a long interval of fasting and persistent calling, until at 11:49 the male brought an insect, then another, 9 minutes later. The spacing of these meals suggested that the male trogon was attending his youngsters alternately, first feeding the one

off in the forest until it was satisfied, then bringing a number of insects in fairly rapid succession to the one in the nest. There is no reason to suppose that the fledgling who had gone out of sight was receiving food from the female.

When I left the blind at 12:15 p.m., the second youngster had not once stood in the doorway, and was resting so quietly in its niche that I thought it would stay until the next day. But when I returned at 4:10 it had gone. If, as is probable, the young trogons left the nest in the order of their hatching, the first was about 14 days old, the second very close to 15 days, at the time of their departure. Although the first flew from the doorsill just after the male alighted on a neighboring branch with food, the male did nothing which I could interpret as an attempt to urge it out. Nor did the parent, as far as I could see, make the least effort to lure the laggard fledgling from the nest, during the period of more than a day that it remained alone. As has nearly always been the way in my experience, the departure of the first youngster was spontaneous, and that of the second probably so.

Of the seven nests of the Black-throated Trogon that I found while, or before, they contained eggs, this alone was successful. In the only other nest that I have known to produce fledged young, they were nearly feathered when I first saw them.

After the nestlings' departure, a heavy deposit of waste material covered the bottom of the nest; the parents had never in my presence done anything to cleanse it. The dark mass was already well disintegrated, and the only recognizable objects were a number of yellowish maggots and a few hard parts of insects, including a beetle's elytron, a leg resembling that of a grasshopper, and a long antenna. Some days earlier, before the nestlings flew, I had removed from beside them the empty exoskeleton of a large green insect, which now had some maggots in it. From the head to the tip of the long ovipositor this insect measured 4¾ inches, and to the tip of the wings it was 2¾ inches. The stout body was about 2 inches long. A number of the insects that I saw the parents carry to the nest appeared to be as big as this, and some even longer. Their size explains the infrequency of the feedings through most of the nestling period. I never detected a fruit in a parent's bill when it visited the nest, and I searched in vain for a regurgitated seed. All the evidence indicated that the nestlings' diet consisted wholly of insects, which are also the chief food of the adults.

Although at this nest the female stopped bringing food at some time between the nestlings' sixth and eleventh days, not all female Black-throated Trogons are so neglectful. At a nest which I kept under observation in 1942, the single nestling vanished when it was 10 or 11 days old. In the late afternoon of the eleventh day after it hatched, I found both parents close by the devastated nest, the male with a long-winged green insect in his bill, the female with some smaller article of food in hers. Later, I saw her cling in front of the empty niche, as though offering a meal to a nestling. The bringing of food to nests from which the young have recently been taken, or in which they lie dead, is

not unusual among birds. I have seen it in the Citreoline Trogon (Skutch, 1948:144), the Collared Trogon (Skutch, 1956:364), and a number of birds in other families. This persistence in food-bringing ensures that weak young, or those which have fallen from the nest, will not be neglected.

Still, the female parent's neglect of older nestlings was not without precedent in my experience with trogons. A female Quetzal gradually lost interest in her family, and to her mate fell the whole care of the two young during their last five or six days in the nest, and doubtless also after their departure (Skutch, 1944:227). A male White-tailed Trogon was the sole provider for a nestling through most of its 25 days in the nest. Both the Quetzal's and the White-tailed Trogon's nests were late in the season; and it seemed that the defection of these females, if indeed the female White-tailed Trogon remained alive, might be attributed to the waning of parental impulses as the breeding season approached its end. But this explanation could hardly apply to the female Black-throated Trogon, whose nest was one of the earliest of the kind that I have known. I can think of just one condition in which the female's abandonment of her brood would be adaptive rather than maladaptative: if there were an excess of males, and she left her first mate in charge of the brood in order to rear another family with a new mate. But this is merely a suggestion, unsupported by observations.

Acquisition of the Adult Plumage

The nestling plumage is described in detail by Ridgway (1911:782), who also describes males in transitional plumage, without, however, giving any information about the period when this is worn. In El General, I have seen young males in transitional plumage in January and April. Since in this region the breeding season, as far as is known, extends from the end of March to June, the young males that I met in April were probably about a year old; and because they still bore the marks of immaturity when others of their kind were nesting, it is also probable that they would not breed until about two years old. Although the males of certain species of birds nest in transitional plumage, all of the males of this and other kinds of trogons that I have seen attending nests wore the resplendent attire of full maturity.

The three young males of whose plumage I have descriptions showed that the dorsal surface of the body acquires the glittering green of maturity well in advance of the ventral surface, the wings, and the tail. On the one that I met on January 4, 1948, the upper parts were largely green; but the sides of the head, front and sides of the neck, and the breast were mostly brown, with some green in the center of the breast. The belly was yellow. The remiges and rectrices resembled those of the adult female; but the eye-ring was bluish and the bill greenish-yellow, somewhat as in the adult male. On April 11, 1954, I

saw a young male whose plumage was similar to that just described, except that the tail contained some short green feathers, just growing out. A male of which I wrote a description on April 23, 1957, had the largely brown head and breast mottled with green, and the tail was farther advanced than in the preceding individual. I could detect just one long, brown feather in its center, and otherwise it resembled that of the adult male. His wings, too, were, as far as I could see, much like those of the adult male. In these males in transitional plumage, a whitish bar separated the brown of the breast from the yellow of the abdomen; and this is of interest because such a bar is a permanent feature in the plumage of certain closely related species, including the Collared Trogon and the Mexican Trogon.

Summary

In Central America, the Black-throated Trogon is confined to the forests below about 2500 feet above sea level. Its diet consists largely of insects plucked from the foliage while the bird hovers in the air. Its mellow notes are low and weak.

Some pairs begin to prepare their nests early in February, but laying seems not to start before the end of March, while the latest young are fledged in June or early July.

Two white eggs are laid in a shallow, unlined niche carved into the side of a decaying, often tottering, slender trunk, at heights of four to 12 feet above the ground.

The female incubates from the late afternoon until the following morning, and the male sits through most of the day, often taking one long session of about eight hours' duration. One male returned in the evening after his mate had replaced him on the nest, and the second time that this unusual behavior was witnessed he brought food and offered it to the eggs, then almost ready to hatch.

In one instance, the incubation period was 18 days or a little more.

The nestlings, sightless and perfectly naked at hatching, are feathered at the age of 11 or 12 days and leave the nest when 14 or 15 days old. They are brooded and fed by both parents. Their food appears to consist wholly of insects, many of them so large that they can scarcely be swallowed. The rate of feeding is usually slow, during the first week about once in two hours for each member of the brood; but after a period of neglect, a single older nestling received seven meals in little over an hour.

One female ceased to feed her nestlings between their sixth and eleventh days, although she brooded them by night until they were 12 days old. But another female—and also a male—brought food to the nest after the disappearance of their single nestling, which would then have been 11 days old.

In their first plumage, males resemble females. They have been seen in transitional plumage in April, when they could hardly have been much less than one year old. Apparently they do not breed until about two years of age.

Literature Cited

Carriker, M. A., Jr.
1910 An annotated list of the birds of Costa Rica including Cocos Island. *Ann. Carnegie Mus.*, 6:314–915.

Eisenmann, E.
1952 Annotated list of birds of Barro Colorado Island, Panama Canal Zone. *Smithsonian Miscel. Coll.*, 117 (5) :1–62.

Ridgway, R.
1911 The birds of North and Middle America, Part V. *U. S. Nat. Mus. Bull.*, 50:xxiii + 859 pp.

Skutch, A. F.
1942 Life history of the Mexican Trogon. *Auk*, 59:341–363.
1944 Life history of the Quetzal. *Condor*, 46:213–235.
1948 Life history of the Citreoline Trogon. *Condor*, 50:137–147.
1953 How the male bird discovers the nestlings. *Ibis*, 95:1–37, 505–542.
1956 A nesting of the Collared Trogon. *Auk*, 73:354–366.

El Quizarra, San Isidro del General, Costa Rica, June 21, 1958

A FIELD STUDY OF TEMPERATURE REGULATION IN YOUNG LEAST TERNS AND COMMON NIGHTHAWKS

BY THOMAS R. HOWELL

The study of temperature regulation in young birds dates back at least to the time of Edwards (1824), who divided nestlings into two groups—those able to maintain a more or less constant body temperature soon after hatching (precocial), and those that are unable to do this, so that their body temperature varies with that of the environment (altricial). The terms in parentheses above are usually used to designate the two groups, but nidifugous (young able to leave the nest site shortly after hatching) and nidicolous (young restricted to the nest and dependent on parental care) are often employed as equivalents of precocial and altricial, respectively. Birds that nest on the bare ground are frequently assumed to be precocial, but there are very few published studies on such species that include measurements of body temperatures of the young. The present study was undertaken in the hope of adding to the limited data available on this subject.

Most of the information presented here was obtained in July, 1955, at Grand Isle, Jefferson Parish, Louisiana. This locality is on the coast of the Gulf of Mexico about 100 miles south of New Orleans. Some additional data were obtained at Los Angeles, California, in August, 1956.

The two species studied were the Least Tern (*Sterna albifrons*) and the Common Nighthawk (*Chordeiles minor*). At Grand Isle both these species lay their eggs on sand or bare ground, and the young may be exposed alternately to intense solar heat and to cooler periods brought on by frequent thunderstorms. The terns are strictly diurnal, and although the nighthawks may be active at any time of the day they are primarily crepuscular and nocturnal in this region during the hottest part of the summer. These two species, although different in most respects, are similar in the type of nest site utilized; it therefore seemed that a comparison of the adaptations of their young to similar environmental conditions would be of interest.

All body temperatures listed are esophageal, in degrees C., and were taken with a quick-registering mercury thermometer unless otherwise noted. I am aware of the shortcomings of mercury thermometers as compared to thermocouples, but the field investigator usually has no choice but to use the former. Therefore, body temperatures recorded may not be as precise as possible but they are consistent and adequate for comparisons between the two species. Environmental temperatures were also taken with the same quick-registering mercury thermometers unless otherwise noted and are in degrees C. It was often desirable to have black-bulb temperatures as a measure of the intensity of solar radiation. "Black-bulbs" were improvised from the black cardboard

tubing of the thermometer case or from a small glass test tube thoroughly blackened with camphor smoke. When held around the mercury bulb of the thermometer, both these "black-bulbs" gave almost identical results. Obviously the readings are not as accurate as those obtained with meteorological equipment, but like the body temperatures they are consistent throughout this study and thus have some comparative value.

Least Tern

On July 1, 1955, I located 15 nests with eggs of this species at Grand Isle in a large level expanse of white sand mixed with shell fragments. As July is late in the breeding season of the Least Tern in this region, these sets of eggs were almost certainly not the first clutches. The nesting area was roughly rectangular and was surrounded on three sides by marsh and bordered by a bayou on the fourth. There was virtually no vegetation and no shade anywhere in the nesting area. No other species were nesting there, but flocks of Black Terns (*Chlidonias niger*) and Laughing Gulls (*Larus atricilla*) were frequent visitors.

Unfortunately, there was little nesting success in this colony. Eight nests were destroyed by children who followed my footprints across the sand, and several others were raided by raccoons from the surrounding marsh. Laughing Gulls apparently preyed on both eggs and young. However, I was able to get some data on a few very young nestlings from three of the nests. I attempted to take temperatures of the nestlings as soon as possible after the brooding parent departed, and I then remained by the nest and took temperatures of the young at regular intervals during their continued exposure to the environment. It was not always possible to tell how soon after departure of the parent the first temperature was recorded, for most of the adult birds in the colony took wing as I approached the edge of the area. In such instances I could record only that the time unbrooded was something greater than the number of minutes that elapsed between sighting an unbrooded nest and taking the temperature.

The results obtained from five nestlings on five different occasions are summarized in Table 1. It will be noted that body temperatures in one- and two-day-old nestlings varied through about 8°C., but did not rise above 42.5°C. in these or in a three-day-old nestling, even though black-bulb and ground temperatures rose above this figure. Presumably the nestlings regulated their body temperature more effectively at the high than at the low end of the scale, and I was able to get additional information on this point in August, 1956, by subjecting nestling Least Terns to heat and cold stress under laboratory conditions.

Two nestling terns were found in a breeding colony at Playa del Rey, Los

TABLE 1

ENVIRONMENTAL TEMPERATURES AND BODY TEMPERATURES (IN °C.) OF FIVE LEAST TERN NESTLINGS ONE TO THREE DAYS OLD

(Each column represents separate, nonconsecutive records)

Time since parent left	> 5 min.	> 5 min.	> 3 min.	> 5 min.	>5 min.[1]
Ground	31.0	42.5	29.5	30.2	49.5
Black-bulb	28.4	44.0	night	28.5	43.0
Air			29.5	28.5	
1 day old	36.2	42.5	37.2	34.2	
2 days old		42.5	38.2	35.0	42.2
3 days old					42.5

[1] Extremely conservative estimate of time.

Angeles, on August 1. One appeared slightly smaller and younger than the other; the smaller one was more white and the larger one more yellow in color. The letters (W) and (Y) are used to distinguish these two young birds in the following discussion. I estimated that (W) was no more than one day old and that (Y) was two days of age at most. Deep esophageal temperatures taken immediately after the brooding parent left were 40.5 (W) and 41.5°C. (Y); during the following hour, these body temperatures (unbrooded) varied only between 40.0 and 41.2°C. (W) and 40.8 and 42.5°C. (Y) at an air temperature (with 5 m.p.h. wind) of 27 to 29°C., a black-bulb temperature of 35.5°C., and a ground temperature of 33 to 36.5°C. A few hours later I returned to the nesting colony and took the two nestlings to the laboratory. They each weighed 5.7 grams, and after about 30 minutes at ambient temperatures of 24 to 30°C., their body temperatures (taken at 4 p.m.) were 33.5 (W) and 35.2°C. (Y). These and other temperatures recorded in the laboratory were measured by a thermocouple. At 4:30 p.m. both birds were placed in a cold chamber at an ambient temperature of 10°C.; this declined gradually to 5.5°C. The laboratory results are shown in Figure 1.

At 4:26 p.m., when the birds were at their lowest body temperature, both were capable of slow movement and (Y) cheeped faintly. The young birds were returned to their nest at 5:03 p.m., and a parent bird settled down to brood them almost immediately.

The next day I returned to this nest and found (W) but not (Y). The body temperature of (W) was 41.6°C. within two minutes after the departure of the brooding parent. When taken to the laboratory again, (W) weighed 6.1 grams, an increase of 0.4 gram over the previous day. At the laboratory room temperature of 23.0°C., the body temperature of (W) dropped to 36.4°C. in about 20 minutes. At this time, 3:57 p.m., (W) was placed in an insulated chamber at an air temperature varying between 43 and 45°C.; results are shown in Figure 2.

It will be noted that during the first six minutes there was a rise of 4.1°C. in body temperature. During the following 16 minutes the bird maintained a fairly constant body temperature, but after that a rise to higher levels commenced. However, the body temperature remained below that of the surrounding air for the entire 38-minute period.

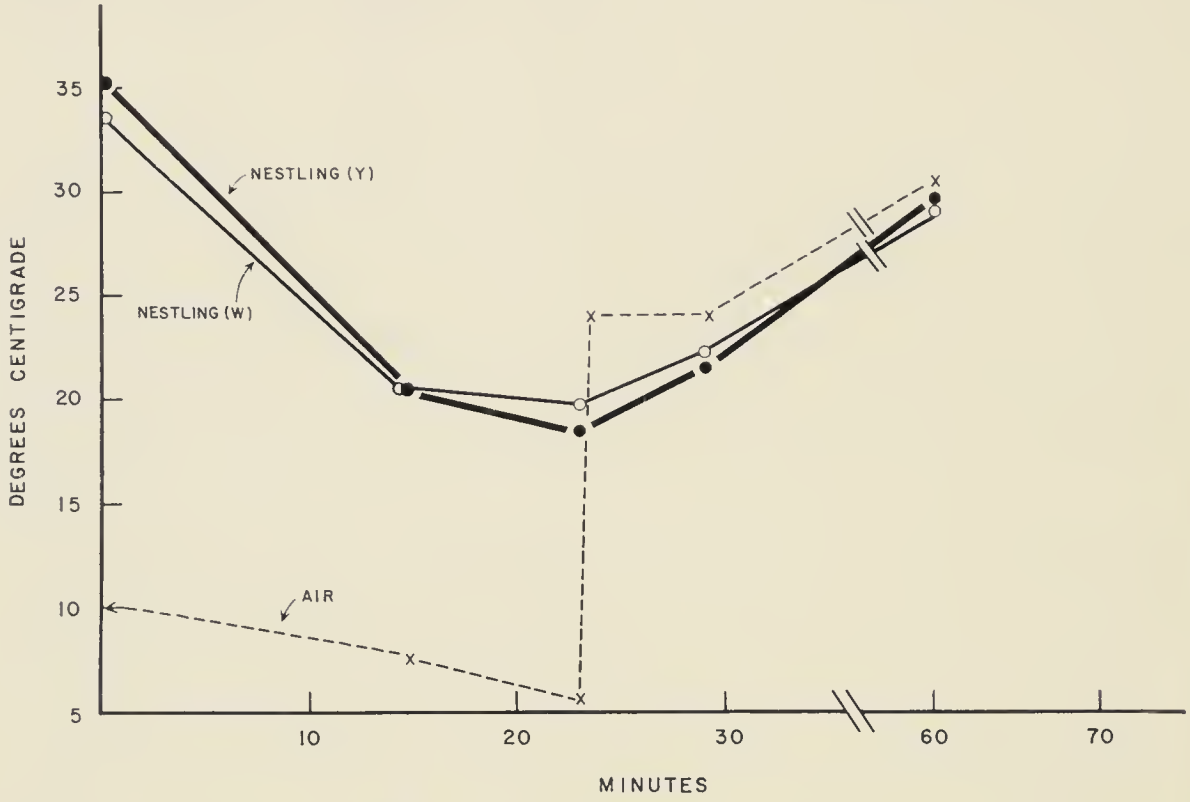

Fig. 1. Responses of Least Terns of approximate ages of one (W) and two (Y) days to low and moderate ambient temperatures.

The bird was visibly affected by the high ambient temperature after five minutes of exposure, for it began to call, hop about, and pant. From this time on the bird seemed to be in a state of increasing distress. Its beak was kept open and its whole body trembled with the effort of violent panting. The respiratory rate was too rapid for an accurate count, and there seemed to be an erythemia of the linings of the mouth and pharynx. The bird was removed from the 45°C. test chamber after 38 minutes and was exposed to ambient temperatures of 23 to 27°C. for the next 35 minutes, during which time it was being returned to its nest. When replaced in the nest at 5:10 p.m., the bird's body temperature had dropped to 35°C.; a parent bird came and settled down to brood the young one as soon as I walked away.

These data indicate that very young nestling Least Terns show considerable lability of body temperature (a range of at least 24°C.) but that they are capable of regulating effectively for at least 38 minutes under severe heat stress.

Comparative information was obtained on a juvenile Least Tern of an estimated age of two weeks. This bird was fully fledged and able to fly, but after two flights of about 40 and 15 yards, respectively, it appeared to be exhausted and was captured by hand. Its body temperature at the time of capture was 39.2°C., and it weighed 37.6 grams. The bird was placed in a closed chamber at an ambient temperature of 20°C. and subsequently at 10°C.; its body temperature at the start of the experiment was 37.6°C. Results are shown in Figure 3.

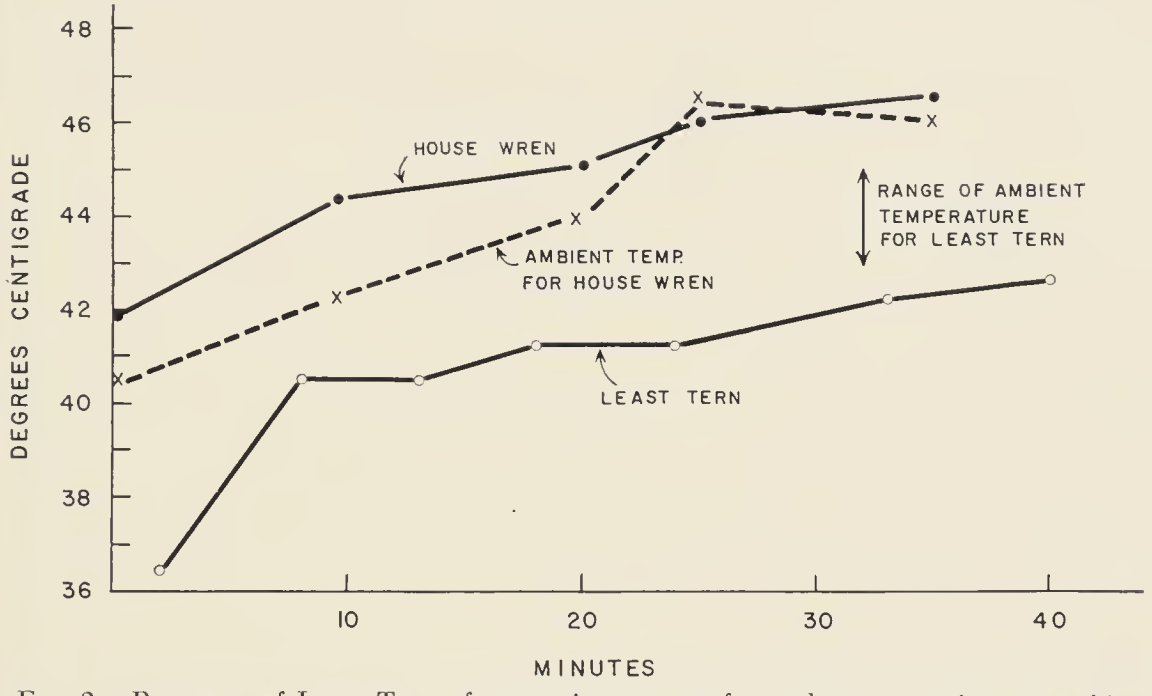

Fig. 2. Response of Least Tern of approximate age of two days to continuous ambient temperatures of 43 to 45°C. Data on House Wren nestling of similar weight is replotted from Baldwin and Kendeigh (1932:118).

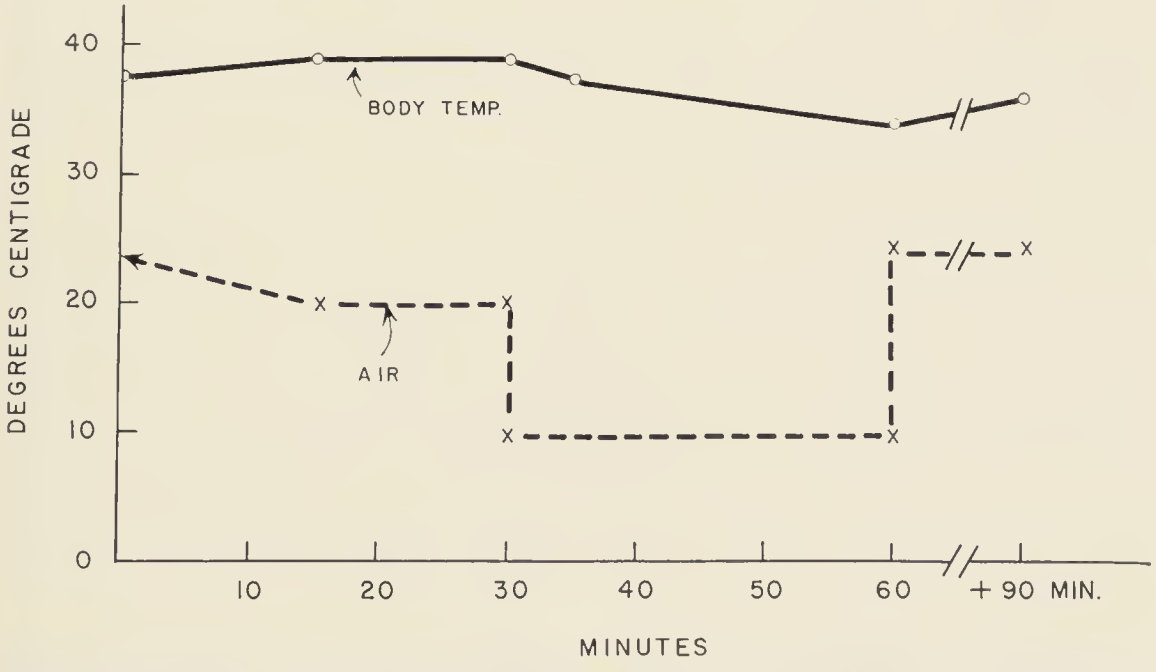

Fig. 3. Response of Least Tern of approximate age of two weeks to varying ambient temperature.

Although this juvenile regulated well at moderately cool ambient tempertures, it showed a drop in body temperature below the usual adult level when subjected to somewhat greater cold stress. The young tern was captured about two hours before the experiment began, and as I did not feed it the bird was without food for at least two hours and perhaps much longer. It may have been running out of energy reserves by the time it was subjected to the ambient temperature of 10°C., and its slow recovery to higher body temperatures supports this suggestion. However, it flew from my hand when I returned it to the nesting colony, and it was last seen running rapidly for cover.

Nighthawk

This species lays its two eggs on the bare sand at Grand Isle, but the nest site is usually among small tufts of vegetation where the concealing coloration of the adults and young is most effective. The vegetation provides small patches of shade, but not enough to shield the parent bird or to cover the sand between adjacent clumps of grass, especially during the middle of the day when solar heat is most intense. July is late in the breeding season of nighthawks in southern Louisiana, and I was not able to find any newly hatched nestlings. The youngest birds I could find were two of an estimated age of five and six days—the estimate based on camparison with photographs of nestlings of known age given in Bent (1940). These young birds were kept under observation for seven days, and additional data were obtained from two others of ages estimated at 15 to 16 days and from a juvenile nighthawk about 24 days old.

As with the Least Terns, I attempted to take temperatures of the young as soon after the departure of the brooding parent as possible and then at regular intervals while the young were unbrooded. In my limited study, I found that the young up to at least 15 days of age were brooded during the entire day. I did not find them brooded during the early part of the night, but no observations were made later than about three hours after sunset.

The brooding parent left the young only when closely approached, and the bird invariably departed with an "injury-feigning" type of flight, as described by Tomkins (1942). The adult nighthawk flopped away with extremely labored wingbeats and with the tail hanging vertically; often the bird collapsed a few yards away with wings and tail spread and mouth gaping. This behavior was a good indication that the parent had just left its young and was quite useful to me in locating them. As I was primarily concerned with getting temperatures of the young immediately, I did not attempt to identify the sex of the brooding parent each time. However, when such identification was made the bird was a female.

The body temperatures of young of different ages under various conditions of exposure are given in Tables 2–4.

Table 2

Environmental Temperatures and Body Temperatures (in °C.) of Two Young Common Nighthawks

	5 to 6 Days Old					6 to 7 Days Old			
	(Consecutive Observations)			(Consecutive Observations)		(Consecutive Observations)			
Time since parent left	2 min.	+ 15 min.	Time lapse	1 min.	+ 15 min.	1 min.	+ 7 min.	Time lapse	> 3 min.
Ground	40.0	40.0		31.5	31.5	41.0	41.0		
Black-bulb				30.0	30.0	41.5	41.5		30.6
Air	33–34	33–34		29.5	29.5	35.5	35.5		29.5
Bird No. 1	39.5	42.0		38.5	36.5	39.8	44.0		38.0
Bird No. 2	38.5	41.0		38.5	37.0	40.5	43.0		38.0

Table 3

Environmental Temperatures and Body Temperatures (in °C.) of Two Young Common Nighthawks

	7 to 8 Days Old						
	(Consecutive Observations)			(Consecutive Observations)			
Time since parent left	1 min.	+ 6 min.	Time lapse	1 min.	+ 15 min.	+ 15 min.	+ 15 min.
Ground	42–43	42–43		31.5			
Black-bulb	38.2	38.2		29.0	29.0	28.5	28.5
Air							27.2
Bird No. 1	40.5	43.0		38.5	37.0	36.4	34.8
Bird No. 2	40.5	43.5		38.2	36.8	37.0	36.8 (active)

Table 4

Environmental Temperatures and Body Temperatures (in °C.) of Two Young Common Nighthawks

	10 to 11 Days Old		11 to 12 Days Old			15 to 16 Days Old
	(Consecutive Observations)		(Consecutive Observations)			
Time since parent left	1 min.	+ 15 min.	1 min.	+ 15 min.	+ 6 min.	> 5 min.
Black-bulb	37.5	34.0	39.0	39.0		
Air	31.0	31.5	32.0	32.0		28.0 (night)
Bird No. 1	39.4	42.0	39.5	42.5		37.8
Bird No. 2	39.0	41.5	39.5	41.5	41.8	38.2

Although the youngest nighthawks were five to six days old, their body temperature at this and more advanced ages was more labile than that of the younger Least Terns under natural conditions. The nestlings of these two species would not normally be exposed to very cold conditions, but the difference in their response to heat is noteworthy. After only seven minutes exposure to hot, direct sun (black-bulb temperature 41.5°C.), nestling nighthawks six and seven days old experienced a rise in body temperature to 43 and 44°C. Even after 38 minutes exposure to an ambient temperature of 43 to 45°C., a two-day-old Least Tern did not reach this level of body temperature. The young nighthawks showed great distress at the elevated body temperatures, and I have little doubt that they would have died if left exposed for 15 or 20 minutes longer. A body temperature of about 46°C. is lethal for the House Wren (*Troglodytes aedon*) (Baldwin and Kendeigh, 1932), and as I did not want to risk having the young nighthawks reach this level and perish I left after the seven-minute interval. A parent bird immediately returned and brooded the young, and they evidently suffered no lasting ill effects. On the following day similar results were obtained, but equally hot environmental conditions did not occur at later stages in the growth of the young and the highest body temperatures subsequently recorded were not over 42.5°C. The lowest body temperature recorded was 34.8°C., after 45 minutes exposure of an eight-day-old bird to an ambient temperature of 27 to 28°C. Gular flutter in response to heat stress was noted in nighthawks of all ages.

The behavior of the nestlings is important with regard to temperature regulation. The five- and six-day-old nestlings were able to run about, although not very rapidly. When the parent was flushed and the young were closely approached, the latter usually ran off for a short distance and then stopped. This running appeared to be essentially undirected, and a nestling was just as likely to come to rest in an open, unshaded spot as in a more concealing and shaded location. If disturbed again or if apparently uncomfortable from exposure, the birds again moved off but often to an equally "unsatisfactory" exposed location. By the time the young were about 11 and 12 days old, however, their movements were much better directed. I was unable to keep them exposed to sun for more than 15 minutes, for after this time they went more or less directly to a nearby patch of shade and remained there unless chased out.

These observations indicate that nestlings under about 12 days of age would not be likely to survive unless closely brooded by a parent. Their body temperature regulation is probably not adequate to cope with exposure to normal extremes of heat for more than a few minutes, and they are unable to reach shelter except by chance. By about 12 days of age their temperature regulation is still imperfect, but the birds are able to seek shade when exposed to intense

solar heat. After an age of about 15 days is reached the young may not be continuously brooded; their body temperature regulation has presumably improved although data on this point are not available. However, I was able to obtain the following information on a bird of slightly more advanced age.

A juvenile nighthawk of an estimated age of 24 days was captured on July 23; it was evidently exhausted after two flights of about 50 yards each and was caught by hand after the second one. This bird was then exposed (with intervening rest periods) to cold stress in a refrigerator and to heat stress by tethering it in full sun. It was then confined in the dark at about 30°C. for 24 hours, making a total of at least 29 hours without food. The results are given in Table 5, and except for a slight drop in body temperature when first subjected to cold and a slight rise after exposure to heat, the various experimental conditions seemingly had little effect; only the drop to 37.5°C. might be considered outside the usual limits of fluctuation. The bird was given food and water at the end of the darkness-starvation period and released in apparently good condition. It seems likely that body temperature regulation in young birds over three weeks old is essentially as effective as that of adults.

TABLE 5

ENVIRONMENTAL TEMPERATURES AND BODY TEMPERATURE (IN °C.) OF A YOUNG COMMON NIGHTHAWK, ESTIMATED AGE 24 DAYS

Conditions:	Exhausted after two flights	20 min. rest	15 min. in refriger-ator	30 min. rest; 30 min. in refrigerotor	30 min. rest; full sun 16 min.	+ 15 min.	+ 13 min.	+ 14 min.	+ 24 hrs. without food
Black-bulb					39.0	39.0		29.0	
Air	28.5	28.6	12.0	12.0	31.0	31.0		27.2	30.5
Body	38.8	39.0	37.5	39.4	41.4	41.5	41.0	40.0	39.5

One other point of possible interest with regard to survival of young nighthawks may be mentioned here. The nesting areas of this species at Grand Isle are inhabited by swarms of the salt marsh mosquito (*Aedes solicitans*), and the hordes of these voracious insects sometimes made prolonged data-gathering by a human observer an impossibility. However, although the youngest nighthawk nestlings had conspicuous areas of bare skin showing along the apteria, I never saw a mosquito alight on a young bird or even hover around one. Probably the nestlings could not survive such locations if they were subject to attack by the more common species of mosquitoes.

DISCUSSION

Body temperatures of nestling gulls (*Larus* sp.) under various environmental conditions have been studied by Barth (1951), Bartholomew and Dawson (1952, 1954), and Behle and Goates (1957). Abdulali (1940)

reported mortality of nestling Least Terns (*S. a. albifrons*) after 15 to 20 minutes of exposure to hot sun, but this observation was incidental to a photographic study and neither ambient nor body temperatures were recorded. I know of no published records of body temperatures of young Least Terns of either Old or New World populations.

The observations of Barth (1951) on young *Larus canus* are closely comparable to those reported here. Barth found body temperatures to range from 16°C. to 44.2°C., depending on age and environmental conditions. After 34 minutes of exposure to ambient temperatures from 41 to 43°C., a four-day-old bird reached a body temperature of 45.3°C. and died. The next highest body temperature reading, 44.2°C., was reached by an 8½-day-old bird after 10 minutes of exposure to an ambient temperature of 47°C.; the body temperature was not lethal in this instance. Barth concludes that the young gulls are better able to *tolerate* low ambient temperatures than high ones but that the capacity for *regulation* is better under the latter conditions. The results reported here on the Least Tern are generally in accord. However, the Least Tern breeds primarily in warm climates where ambient temperatures as low as those occurring in some high latitude gull colonies do not occur. It appears that very young Least Terns regulate at least as well at high ambient temperatures as somewhat older nestling gulls. As ambient temperatures high enough to constitute a threat to the survival of young Least Terns may be expected to occur during their breeding season, it is not surprising that this species apparently has evolved more effective regulation of body temperature under heat stress. It may be noted that the small size of the Least Terns as compared with gulls means a relatively larger body surface, and this makes even greater the problem of heat loss when the air and/or substrate temperatures are higher than the body temperature.

Bartholomew and Dawson (1952) recorded temperatures of young Western Gulls (*Larus occidentalis*) of ages varying from those in pipped eggs to at least two weeks old. Even in pipping young that were unbrooded for 45 minutes, the body temperatures were no less than 32.3°C. at an air temperature of 27°C. In contrast, a hatchling Least Tern did not regulate as well as this at ambient temperatures that were slightly higher (Table 6). In this instance the relatively greater body surface of the small tern would tend to increase heat loss to a cooler environmental temperature.

Behle and Goates (1957) studied young California Gulls (*Larus californicus*) from the pipped egg stage up to about 21 days of age. The ambient temperatures and the duration of time unbrooded differed from those to which the Least Terns were subjected, and the data cannot be closely compared. Incompletely hatched California Gulls at air temperatures from 29 to 33°C. had body temperatures between 36 and 37°C.; this seems to indicate better

capacity for regulation than in the Least Tern (Table 6) at a slightly later and drier stage, but the time unbrooded was not known for the young gulls and the comparison is thus of doubtful value.

Table 6

Environmental Temperatures and Body Temperature (in °C.) in a Newly Hatched Least Tern

	(Consecutive Observations)			(Consecutive Observations)		
Age	4 hrs.	+ 15 min.	Time lapse	17 hrs.	+ 15 min.	+ 15 min.
Ground	34.8	34.8		26.6	26.6	26.6
Black-bulb	34.0	35.8		30.5	29.5	29.5
Air		31.6		27.8	28.6	28.5
Body	39.5	36.0		35.8	31.0	30.2

Rolnik (1947) studied the effects of cold on the young of several species of gulls and other birds nesting on arctic islands in the Barents Sea. He found that a one-day-old Kittiwake (*Rissa tridactyla*) weighing 38.5 grams went from a body temperature of 36°C. to 19.8°C. after 75 minutes at an air temperature of 6.5°C. In contrast, the 5.7 gram Least Terns studied by me took only 23 minutes to reach body temperatures of 18.5 and 19.8°C. under very similar conditions (Fig. 1). Here again, the small size of the tern nestlings is undoubtedly important in accounting for this difference in rate of cooling.

Rolnik also described a state of "apparent death" in nestlings at body temperatures of 9 to 15°C. from which the birds fully recovered when warmed. His interesting experiments deserve to be repeated, especially with temperate and tropical charadriiform species.

Data on body temperature regulation of altricial birds of a size comparable to young Least Terns are given by Baldwin and Kendeigh (1932) and by Dawson and Evans (1957). Baldwin and Kendeigh give weights of young House Wrens at four days and at 11 days as 4.6 and 10.4 grams, respectively; presumably young wrens at age five to seven days would weigh about five or six grams and thus approximate the weight of the young terns. Baldwin and Kendeigh (1932:118) show the response of a seven-day-old wren to high air temperature. These data are replotted on Figure 2, illustrating the relatively poor regulatory capacity of the young wren as compared to that of a young tern of similar size.

Dawson and Evans (1957) give figures on body temperatures of young Field Sparrows (*Spizella pusilla*) and Chipping Sparrows (*S. passerina*) at air temperatures of 10 to 40°C. Three-day-old sparrows of these species are comparable in weight (mean weights 5.9 and 5.5 grams, respectively) to the youngest Least Terns. The body temperature of the sparrows at age three days

appears to vary almost directly with the air temperature but remains slightly above it, especially at the higher end of the scale where the difference is on the order of 5°C. The nestling terns showed much greater capacity for temperature regulation than this.

In summary, it appears that young Least Terns regulate their body temperature as well or better than young gulls of similar age in response to high ambient temperatures, somewhat less effectively than gulls in response to low ambient temperatures, and, of course, much better than altricial nestlings of similar age and size at either high or low ambient temperatures. However, if one compares age from beginning of incubation in the terns and in the altricial sparrows, it is evident that the latter achieve essentially complete homeothermy in a shorter period of time. The incubation period of the Least Tern is about 21 days whereas that of the Field and Chipping Sparrows is 11 to 12 days. The sparrows achieved homeothermy at 7 to 10 days after hatching or about the 18th to 21st day after the start of incubation (Dawson and Evans, 1957); the newly-hatched Least Tern, at a "total age" of 21 days, is quite imperfectly homeothermic.

It is equally evident that young nighthawks are not precocial in a strict sense although they exhibit some characteristics of that condition. They are covered with down on hatching and are active at an early stage; indeed, they are nidifugous although not fully homeothermic. This raises the question of whether the order Caprimulgiformes can be called either precocial or altricial, whether some members of the order are definitely one or the other, or whether an intermediate condition prevails throughout the group. There is no unanimity in the literature on this order. The Heinroths (1924–33) regard the ground-nesting species as semiprecocial and the tree-nesting types (such as *Nyctibius*) as altricial. Witherby *et al.* (1938) consider the "young helpless"; A. O. Gross (Bent, 1940:221) says of the Common Nighthawk that "on the first day the young are able to stand upright and are very active at the time of hatching." Weller (1958) supports this observation, and Pickwell and Smith (1938) describe hatchling Lesser Nighthawks (*Chordeiles acutipennis*) as fully able to move about. Similar comments are found in Bent (1940) with regard to the young of other North American caprimulgids such as *Caprimulgus carolinensis* (p. 151), *C. vociferus* (p. 169), and *Nyctidromus albicollis* (p. 201). Aldrich (1935) found nestling Poor-wills (*Phalaenoptilus nuttallii*) to be active, but Brauner (1952) reported that in three-day-old Poor-wills the body temperature went as low as 20.3°C. at an ambient temperature of 12.6°C. after a little over two hours unbrooded. In view of the great lability of body temperature under certain conditions in the Poor-will and in the Lesser Nighthawk (Marshall, 1955), it is likely that extensive further investigation of temperature regulation in both nestlings and adults of any caprimulgiform

species would be worthwhile. The almost complete absence of temperature data on nestlings makes any generalization tenuous, but it appears that the young of some caprimulgiforms look and act like precocial nestlings but lack the degree of homeothermy associated with that condition.

Summary

Young Least Terns (*Sterna albifrons*) and Common Nighthawks (*Chordeiles minor*) were subjected to heat and cold stress under field and laboratory conditions and their responses in terms of body temperature were recorded. Very young Least Terns are imperfectly homeothermic; they regulate body temperature less well at low air temperature but better at high air temperature than gulls of similar age, and their capacity for temperature regulation is much better than that of altricial nestlings of similar size. Young Common Nighthawks are even more imperfectly homeothermic, and they appear to be intermediate between the precocial and altricial conditions.

Literature Cited

Abdulali, H.
1940 The sun as a mortality factor among young birds. *Jour. Bombay Soc. Nat. Hist.*, 41:433–434.

Aldrich, E. C.
1935 Nesting of the Dusky Poor-will. *Condor*, 37:49–55.

Baldwin, S. P. and S. C. Kendeigh
1932 Physiology of the temperature of birds. *Sci. Publ. Cleveland Mus. Nat. Hist.*, 3:1–196.

Barth, E. K.
1951 Body temperature of the young of gulls (*Larus*). *Nytt Magasin for Naturvidenskapene*, 88:213–245.

Bartholomew, G. A. and W. R. Dawson
1952 Body temperatures in nestling Western Gulls. *Condor*, 54:58–60.
1954 Temperature regulation in young pelicans, herons, and gulls. *Ecology*, 35:466–472.

Behle, W. H. and W. A. Goates
1957 Breeding biology of the California Gull. *Condor*, 59:235–246.

Bent, A. C.
1940 Life histories of North American cuckoos, goatsuckers, hummingbirds and their allies. *U.S. Nat. Mus. Bull.*, 176:viii + 506 pp.

Brauner, J.
1952 Reactions of Poor-wills to light and temperature. *Condor*, 54:152–159.

Dawson, W. R. and F. C. Evans
1957 Relation of growth and development to temperature regulation in nestling Field and Chipping Sparrows. *Physiol. Zool.*, 30:315–327.

Edwards, W. F.
1824 De l'influence des agents physiques sur la vie. Paris.

Heinroth, O. and M. Heinroth
1924–33 Die Vögel Mitteleuropas. Berlin.

Marshall, J. T., Jr.
1955 Hibernation in captive goatsuckers. *Condor*, 57:129–134.
Pickwell, G. and E. Smith
1938 The Texas Nighthawk in its summer home. *Condor*, 40:193–215.
Rolnik, V. V.
1947 The phenomenon of "apparent death" by birds. *Zool. Zhur.*, 26:345–350.
Tomkins, I. R.
1942 The "injury-feigning" behavior of the Florida Nighthawk. *Wilson Bull.*, 54:43–49.
Weller, M. W.
1958 Observations on the incubation behavior of a Common Nighthawk. *Auk*, 75:48–59.
Witherby, H. F., F. C. R. Jourdain, N. F. Ticehurst and B. W. Tucker
1938 The handbook of British birds. Vol. II. London: H. F. and G. Witherby.

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OBSERVATIONS ON THE FULVOUS TREE DUCK IN LOUISIANA

BY BROOKE MEANLEY AND ANNA GILKESON MEANLEY

The Fulvous Tree Duck (*Dendrocygna bicolor*) is a locally common breeding bird of the rice fields of southwestern Louisiana. The "Mexican Squealer," "Yankee Duck," or "Canard Yankee," as it is variously known to the Cajun rice farmer, is probably more closely associated with this cultivated marsh type than is any other bird. In Louisiana the tree duck nests only in rice fields, as far as can be ascertained; no breeding records for it have been reported from the coastal marshes, though it is found there regularly before and after the nesting season.

The first authentic nesting records of this species in Louisiana were reported by Lynch (1943) for August 13, 1939. He found several nests in Acadia Parish rice fields and made notes on nesting habits. The status of the Fulvous Tree Duck in this area before the introduction of rice culture is conjectural. Early occurrence records coincide fairly closely with the introduction of rice culture shortly after the Civil War. Lynch (*ibid.*) says that "it is not impossible that rice culture made possible the extension of the nesting range of this bird into Louisiana, since most of this region had been prairie prior to cultivation."

Since information on the Fulvous Tree Duck in this area is scant, we made a study of its ecology and local distribution during 1955, 1956 and 1957. Observations were made in all rice-producing parishes but were centered mainly in Evangeline and Jefferson Davis parishes, where the greatest concentrations occur during the nesting season.

Nesting densities in two large areas were estimated by counting the number of paired birds that regularly visited certain feeding fields. In one study tract, the number of pairs occupying nesting fields was determined by census. The search for nests occupied considerable time because of the difficulty of locating them in dense stands of rice, which were often over five feet high. Farmers helped locate several nests. Habitat preferences were appraised by surveys of various areas where the ducks were known to occur. Information on depredations upon crops was obtained through inspections of rice fields where Fulvous Tree Ducks had been feeding. U. S. Fish and Wildlife Service field reports provided additional material on this subject.

Distribution and Populations

In seasons other than the breeding period, the Fulvous Tree Duck has been reported from marshlands of the coastal parishes extending from the Mississippi River to the Texas border. Lowery (1955) reported that it was known to occur within the state during every month of the year except February.

Before rice planting begins in March and April, many Fulvous Tree Ducks concentrate in the fresh-water marshes of Vermilion and Cameron parishes. On the Lacassine Refuge, in Cameron Parish, the preferred marsh type is a fairly uniform stand of "Paille Fine" or maidencane (*Panicum hemitomon*) containing many small ponds (Fig. 1). Watershield (*Brasenia Schreberi*) is abundant in most of these ponds (Fig. 2).

FIG. 1. Coastal Marsh habitat in Cameron Parish, Louisiana. "Paille Fine" dominant vegetation.

FIG. 2. Pond of watershield in "Paille Fine" marsh.

In the spring, the first rice fields occupied by Fulvous Tree Ducks are in the area bordering the coastal marshes and extending inland about 20 miles. As these lower rice fields are being planted, flocks of the birds loaf and feed in the native marsh throughout the day and fly into the fields to continue their feeding at night. Fish and Wildlife Service personnel estimated that in May, 1945, 5000 tree ducks were operating between the Lacassine Refuge marsh and adjacent newly-sown rice fields.

A progressive movement of tree ducks into the northern tier of rice-producing parishes occurs as the young rice plants in these interior areas attain a height of eight or ten inches. By the end of April, when the earliest rice is a foot high, most Fulvous Tree Ducks are pretty well dispersed over the rice country in the vicinity of their breeding grounds.

The breeding range extends into all rice-producing parishes of Louisiana, with the exception of a small area located in the extreme northeastern section of the state. Principal nesting areas lie north and northeast of the Lacassine Wildlife Refuge in Jefferson Davis, Acadia and Evangeline parishes. The

greatest nesting concentrations appear to be in the northern part of the rice belt (Fig. 3) rather than in rice fields adjacent to the coastal marsh. This may be because rice usually is planted first in the northern part of the rice belt; drainage is better in that area and the farmer can prepare his seed bed earlier.

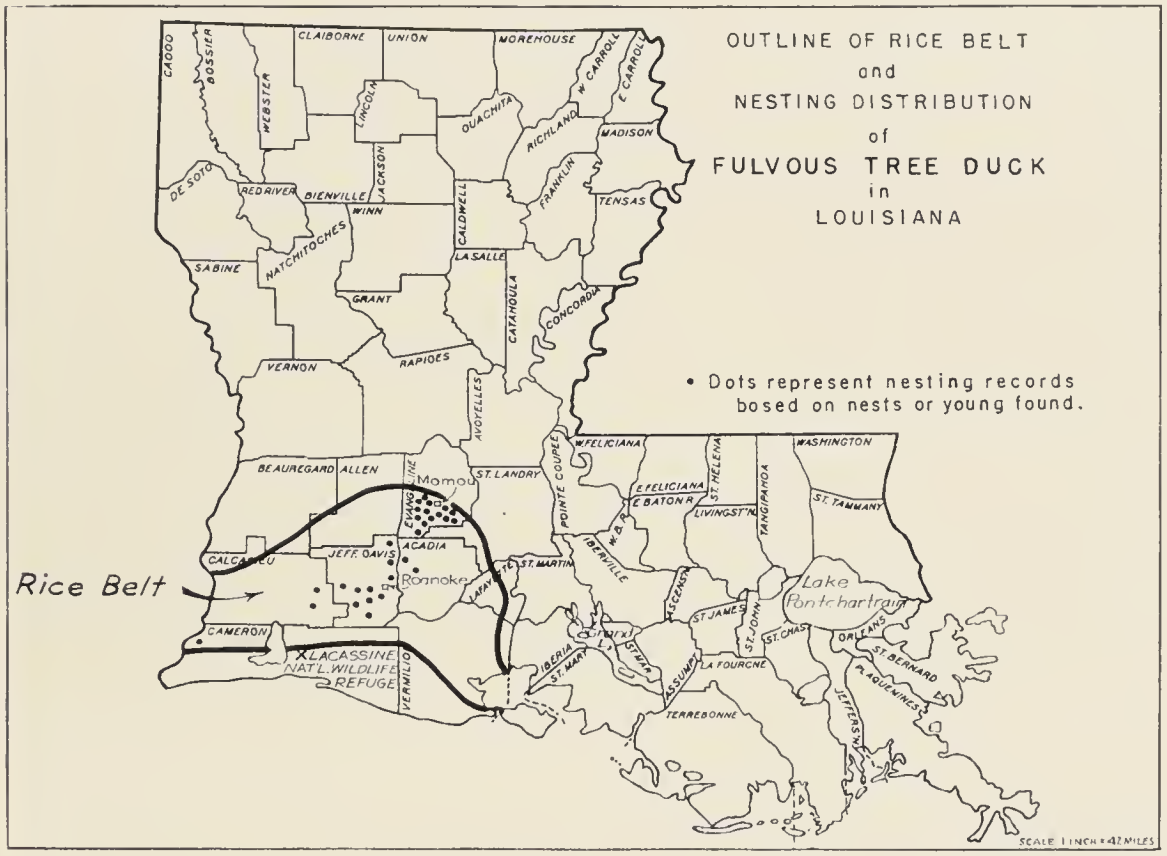

Fig. 3. Rice belt and nesting distribution of Fulvous Tree Duck in Louisiana.

We attempted to determine nesting densities in two localities in which tree ducks seemed to be most abundant. At Mamou, in Evangeline Parish, approximately 20 pairs nested in a five-square-mile area; while at Roanoke, in Jefferson Davis Parish, approximately 13 pairs were in a five-square-mile area. Nesting densities for small areas may be considerably higher, as several pairs often nest in a single field. One rice farmer located six nests in several contiguous rice fields, comprising 400 acres, on his farm near Mamou. High nesting densities in these areas may be related to the fact that they are almost due north of the Lacassine Refuge marsh, one of the important concentration points before and after the nesting season.

Following the nesting season, in late August and early September, tree ducks begin moving into large ponds, lakes, openings in mature rice fields, and flooded rice stubbles. At Mamou, a favorite gathering area is a shallow 200-acre lake. On September 17, 1955, we observed 140 tree ducks on this lake.

On September 27, 1955, approximately 500 were recorded feeding in rice stubbles and potholes in mature fields at Roanoke. Claude Lard, manager of the Lacassine Wildlife Refuge, reported that the tree duck occurs on the refuge throughout most of the year, but reaches its peak population between the latter part of August and the end of September. He recorded a flock of 3000 birds during this period in 1954 (letter of August 19, 1955).

In 1955, tree ducks had moved southward out of the northern rice-producing parishes by October 15. This movement was coincident with the first cold wave of the season and with termination of the rice harvest. To our knowledge, the latest fall flight occurred the evening of November 2, 1955, when 200 tree ducks flew over Bayou Lacassine in the direction of an inundated field of rice stubble.

Winter records in the coastal marshes are fairly numerous and include the following: four on November 25, 1956, at the mouth of the Mississippi River (R. Beter, personal communication); 400 on a 1940 Christmas count at the Lacassine Refuge (U. S. Fish and Wildlife Service files); 500 in the marshes at Chenier au Tigre, on the southwest coast of Vermilion Bay, between December 8 and 18, 1925 (A. M. Bailey, 1928). Winter recoveries of banded and recaptured birds at Avery Island were reported by E. A. McIlhenny as follows:

Banded	Recaptured
September 18, 1937	December 11, 1937
September 14, 1940	December 30, 1942
September 27, 1941	1944–45 hunting season
September 27, 1941	December 14, 1942

Wintering populations such as those mentioned above are not recorded from Louisiana every year; it is the opinion of several wildlife biologists and game enforcement officers who work in the coastal marshes that most of the tree ducks migrate southward to Mexico in winter. At present, however, there are no banding records to support this view.

Nesting Ecology

Extensive areas of rice fields form the optimum nesting habitat of the Fulvous Tree Duck on the Louisiana prairies. Fields heavily infested with weeds appear to be preferred over purer stands.

In several localities, tree ducks were observed both feeding and nesting in the same weedy rice field; in certain other areas, a single weed-infested field was selected for feeding only. Among the more common herbaceous weeds occurring in Louisiana rice fields are: signal grass (*Brachiaria extensa*), knot grass (*Paspalum distichum*), bull paspalum (*Paspalum Boscianum*), jungle rice (*Echinochloa colonum*), barnyard grass (*Echinochloa crusgalli*), Walter's millet (*Echinochloa Walteri*), sedge (*Cyperus* spp.), mud plantain (*Heteranthera limosa*), and smartweed (*Polygonum* spp.).

Nests were situated either on rice field levees or between levees over water. Six of eight nests we found were located over water between levees. These nests were attached to growing plants. The floors of the nests were several inches above the water level, which generally is fairly constant in rice fields.

Rice (*Oryza sativa*), the dominant plant of the area, is the principal material used in construction of most nests. In two nests we found rice plants which had been pulled up by the roots. Some late nests had the ripening grainheads of rice woven into them. One early nest was constructed entirely of signal grass. This nest was found in a pure stand of signal grass, which had crowded out the rice over an area of about a quarter of an acre. Most nests had a canopy of vegetation pulled over them (usually after the clutch was complete), and several were equipped with ramps leading to the rims. One nest had an S-shaped ramp four feet long. The depth of this nest from ground to top of rim was 11¼ inches and the inside width at top was 12¾ inches. None of the nests contained down.

Nesting associates of the Fulvous Tree Duck in Louisiana rice fields, in order of relative abundance, are: Redwinged Blackbird (*Agelaius phoeniceus*), Purple Gallinule (*Porphyrula martinica*), King Rail (*Rallus elegans*), Least Bittern (*Ixobrychus exilis*), and Long-billed Marsh Wren (*Telmatodytes palustris*). These nesting associates usually nest in May, June and July, but there are also August records for each.

Breeding Activities

When tree ducks arrive in the spring, the ponds and rice stubble are already occupied by paired Blue-winged Teal (*Anas discors*). Most tree ducks feed, sleep and move about in groups, although individuals or odd numbers of birds may freely leave one group for another. It seems that some tree ducks pair after their arrival on the breeding grounds.

During this early period, small groups engage in eccentric flights. Two, three, or four ducks will fly about in unison, in a flight that is characterized by much twisting, turning and sharp banking from side to side. On one occasion we observed three males (identified by their calls) following a female on the ground. The female maintained a three- to ten-foot lead, but if the males stopped following, the female moved closer to them until they began to follow again. Whenever a calling female flew over a field, many males standing on the ground immediately answered the call.

Nesting begins about the middle of May, or as soon thereafter as the rice is high enough to provide nesting cover. The earliest record for Louisiana, as far as can be ascertained, is of a nest with one egg found at Mamou on May 25, 1956. At Mamou we also found a nest with six eggs on June 8, 1956; one with six eggs on June 23, 1956; and one with five eggs on July 8, 1957. At

Elton, a nest with five eggs was located on July 4, 1955, and one with 23 eggs on July 16, 1955 (Fig. 4). Nesting may occur even later, for three downy young, approximately 30 days old, were banded on September 17, 1955.

Fig. 4. Nest of 23 eggs of Fulvous Tree Duck in mature rice field at Elton, Louisiana, July 17, 1955.

The nest we discovered at Mamou on June 8 eventually contained 13 eggs, which is about average clutch size for the Fulvous Tree Duck. Clutches in several nests found by Lynch (*ibid.*) varied from 10 to 15 with an average of 13. "Dump nests" are not uncommon with this species, as exemplified by the nest of 23 eggs, referred to above. W. L. Dawson (1923) describes such a nest in California that contained 62 eggs. We flushed three adult birds from within five feet of a nest containing nine eggs. The day before it contained only seven.

Johnstone (1957) found the incubation period for captive birds to be 26 days. The following observations on wild birds also indicate an incubation period of approximately that length: Nest A contained six eggs when it was first located on June 8; it had nine eggs on June 9, and 13 on June 15; several eggs were pipped on July 5; three had hatched by July 6. Nest B had a single egg when it was found on May 25: it contained eight eggs on June 1; on this date the eggs were placed under a domestic hen, and they hatched 24 days later.

Apparently both the male and female share in most phases of nesting activity. Pairs were seen flying together over rice fields throughout the nesting season. They were frequently observed flying together to and from their nests

and were often observed together with their brood. Delacour (1954) suggests that the male probably spends more time at the nest than the female.

Notes on Development of Young

A downy young (female) raised in captivity lost its egg tooth on the fourth day (Fig. 5). At 35 days, quills on wings and tail appeared (with feathers showing at tips of quills). At the same time, the legs began changing color from olive-green to blue-grey, very nearly the adult color. At 40 days the juvenal plumage began to appear on the upper back, flanks and front of the neck (Fig. 6). At 60 days, a remnant of the downy cheek stripe was still present, and nearly complete juvenal plumage had developed, except for rectrices and remiges. At 63 days the cheek stripe was completely gone, and initial flight occurred. Weights of this young female were as follows:

Age in days	Weight in grams
4	28.4
6	32.3
8	34.7
33	223.8
60	523.0
365	654.0

Two ducks in breeding condition weighed 747.7 grams (male) and 771.4 grams (female). This pair was collected from a rice field at Roanoke, Louisiana, on May 30, 1956.

Fig. 5. Downy young four days old.

Fig. 6. Captive tree duck six weeks old.

Fate of Nests and Young

Nesting success of first attempts may not be high, for only three of the 10 we observed were successful. Renesting undoubtedly compensates for this low figure. The early nests are particularly vulnerable to destruction and theft by farm hands, who find them in the course of "rogueing" rice fields for undesirable weeds during late June and July. On many farms this operation consists of a rather systematic coverage by a crew of boys and men walking abreast throughout a field.

A few farmers detest the tree ducks so much that the nests are destroyed whenever they are found, as are the nests of the Purple Gallinule. More often, however, the eggs are gathered and placed under a barnyard hen. Upon hatching, the young ducks usually seem to adapt readily to their surroundings. In 1955, we saw ducklings of 15 different broods in 14 barnyards. Some of these young ducks die at an early age, or are eventually eaten, while others are kept as novelties. During the summer of 1955, a farm boy showed us two dead broods of downy young, which drowned in heavy rainstorms before they were a week old. Fortunately for the tree duck, there is a considerable period following the "rogueing" operation when there is relatively little human activity in the rice field. Nesting attempts at this time are more likely to be successful than those made earlier.

Raccoons (*Procyon lotor*), opossums (*Didelphis marsupialis*), skunks (*Mephitis mephitis*) and domestic dogs wander in rice fields and on rice field levees and may destroy some nests or young. The broken eggs we saw in one nest probably had been destroyed by a raccoon. One young tree duck was found dead on a highway bordering a rice field. Man is, however, the principal decimating factor.

Since the rice harvest begins in late July, and some ducks are still nesting through August, a few nests may be destroyed each year by the combine. The eggs in a nest we studied at Elton, Louisiana, began hatching on August 6, 1955, just four days before harvesting operations began.

Foods

From field observations and stomach examinations (see Table 1) it is obvious that rice is an important food in water-planted fields near the coast. Seeds of this cultivated plant comprised 78 per cent of the food of 15 tree ducks collected and examined by Imler (1944). These ducks were collected from newly sown fields in April and May of 1944. In the late summer and fall rice appears to be less important in their diet, even though it is again abundantly available either in the stubble or standing in unharvested fields. There was only a trace of rice in the gullets and gizzards of five birds and in 100 droppings collected in late summer and fall; instead, weed seeds formed the bulk of the food.

TABLE 1

FOODS OF THE FULVOUS TREE DUCK IN LOUISIANA
(BASED ON 200 DROPPINGS AND 20 GIZZARDS)

SPRING

Dry-planted fields Upper Rice Belt[1] (100 droppings)	Per Cent	Water-planted rice Fields near Coastal Marsh[2] (15 gizzards)	Per Cent
Fimbrystilis sp.	65	*Oryza sativa*	78
Paspalum distichum	25	*Brasenia Schreberi*	11
Eleocharis sp.	10	Misc. weed seeds (*Setaria, Paspalum, Caperonia, Ranunculus*)	11
Oryza sativa	trace		

EARLY FALL

Rice stubbles and mature rice fields[3] (Gizzards and gullets of 5 birds)	Per Cent	Rice stubbles and mature rice fields[3] (100 droppings)	Per Cent
Paspalum distichum and *P. Boscianum*	50	*Echinochloa colonum* and *E. Walteri*	45
Cyperus rotundus	30	*Paspalum distichum*	30
Echinochloa colonum and *E. Walteri*	20	*Oryza sativa*	15
		Misc. sedges and grasses	10

[1] Rice drilled or disked into dry soil.
[2] Field flooded and sown by airplane.
[3] Evangeline and Jefferson Davis parishes.

The importance of rice in the spring diet may reflect the relative scarcity of weed seeds during that period. It is true, however, that some weed seeds are available at the time rice is sown, particularly in pasture fields that were in rice the previous year. Weed seeds are available also in the native marsh where the ducks forage during the early part of the planting period. The gullets of two tree ducks collected from wet pastures at Roanoke, Louisiana, on May 30, 1956, were crammed with the seeds of knot grass, signal grass, and Walter's millet. Seeds of watershield, which are commonly found in the native marsh, formed 11 per cent of the food contents of 15 tree ducks collected by Imler (*ibid.*) in April and May.

In late summer and early fall, grassy spots in rice fields provide excellent foraging sites. The panicles of several aquatic plants such as knot grass, signal grass and jungle rice, extend just high enough above the surface of the water to be convenient for feeding ducks.

When foraging for food in deeper waters, such as ponds or small impoundments, tree ducks feed by "tipping." On occasion, they also make short dives in which their entire bodies disappear under water. In shallow water, they poke their heads and necks beneath the surface without tipping (Fig. 7).

Fig. 7. A typical feeding posture of Fulvous Tree Duck.

Depredations

The Fulvous Tree Duck is often charged with depredations upon newly sown rice fields in the spring and on the maturing fields in late summer and early fall. Damage in the spring usually occurs in fields that were flooded at the time of sowing. If the weather is warm, the rice sprouts in four or five days, and the field is then drained for a few days before being flooded again for the summer. As this first draining takes place, tree ducks, Blue-winged Teal, Redwinged Blackbirds and Boat-tailed Grackles (*Cassidix mexicanus*) flock to the mud flats and shallow pools to feed on the sprouting seeds.

Tree ducks ordinarily feed in these fields at night. In late April, they usually depart from the coastal marshes at about 8:00 p.m. for their journey to the rice fields. On bright nights they could be observed in this flight and were seen to be moving fast and usually in small, tight flocks of 30 or 40 birds. Tree duck damage in spring is confined to a few fields in the rice belt, both because of the relatively small population of birds and the limited area of water-planted rice.

Personnel of the Branch of Game Management and Branch of Wildlife Research, U. S. Fish and Wildlife Service, made a study of tree duck depreda-

tions in Louisiana rice fields in 1944. Reports (Imler *et al.*, 1944; and Davis *et al.*, 1944) of these investigations showed that in limited sections tree ducks may take nearly all of the seed, while over most of the area their feeding will result only in a thinning of the stand. Ducks destroyed as much as three per cent of seeds in some 30 per cent of the fields which contained water-planted rice. It was assumed that more seed would have been taken if the fields had been entirely unprotected by the farmer. Actual crop damage was not nearly as severe as suggested by the destruction of the seed in the spring. For in the fall evaluation it was found that in most fields where the rice seed had been nearly cleaned up, the rice plants had stooled out and filled in the gaps. The reappraised damage thus was estimated to be one half of one per cent.

In early fall, after nesting is complete, tree ducks continue to feed in fields of ripening grain and in stubble fields that still have water on them. The seeds of grasses, sedges and other aquatic plants that grow in rice fields form the major food during this period. Nevertheless, many farmers contend that flocks of tree ducks feed mostly on the ripening rice, or otherwise damage the rice by opening up and enlarging potholes. An inspection of these potholes revealed that many of them are a result of the nesting of the Purple Gallinule. In many places where a gallinule builds its nest, the rice is knocked down for a radius of 5 to 10 feet and numerous potholes develop. Certain open pond areas in rice fields also may be the result of poor cultural methods. Ducks frequent these potholes primarily to forage for grass seeds, and do occasionally enlarge them somewhat.

J. J. Carroll (1932), in writing about depredations in Texas, presented another view on this matter. "In July and August when the rice is in 'the milk,' that is to say when the kernels are soft and juicy, this duck wreaks havoc in the rice fields. The plant is bent over by the weight of the bird's body and the 'head' containing the grains completely nibbled off. When it is taken into account that a flock of a thousand or more may descend into a field in one night some idea may be gained of the heavy damage resulting. The largest numbers are to be seen in the late fall just before the southward migration."

In July, 1957, we observed over 200 tree ducks in a rice field across the road from the Texas Rice-Pasture Experiment Station, a few miles west of Beaumont. The director of this station informed us that he was not aware of any depredations and had not received a single complaint. In early October, 1955, we spent two days at Roanoke, Louisiana, observing a flock of 500 tree ducks that were working through rice fields and stubbles in an area of approximately five miles. While contingents of this flock occasionally alighted in openings in mature rice fields, most of the feeding and loafing took place in one flooded stubble field. Although from three to five per cent of the rice remained in the

stubble after the harvesting operation, several birds collected from this flock had been feeding only on weed seeds.

In mid-August, 1956, when most of the rice fields had been harvested in the vicinity of Mamou, Louisiana, a flock of some 150 tree ducks shifted their activities to a field in the "milk" stage of development. A thorough inspection of this field failed to reveal any damage to rice plants by the ducks. They were feeding entirely within the numerous grassy pools that were located in the field.

Several days prior to harvesting, rice fields are drained to facilitate the combine operation. The progressive draining of the fields results in drying up of most of the stubble by mid-fall, and the ducks then return to the coastal marsh.

It would be impossible to estimate the number of tree ducks that are shot during the rice planting and ripening periods. Since the majority of rice fields are sown by drilling (a practice which does not attract the tree duck) rather than by water planting, illegal shooting is confined to relatively few areas in the spring. Some farmers make a regular practice of shooting these birds in an attempt to "protect" their fields. No duck is more easily killed as it circles within range over the gunner's head. It is fortunate for the tree ducks that most of them migrate southward prior to the opening of the waterfowl hunting season.

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Summary

The Fulvous Tree Duck is a locally common breeding bird of the rice fields of southwestern Louisiana. Observations made in 1955, 1956 and 1957, showed that this species was probably most abundant in the vicinity of Mamou, Evangeline Parish, and Roanoke, Jefferson Davis Parish. Tree ducks arrive in the rice country as the rice is planted in the spring and usually depart following fall harvest. A few winter in the coastal marshes. The nesting period extends from late May well into August. Thirteen and 20 pairs were found nesting in two separate five-square-mile areas. All nests observed were in rice fields. Clutch size in several nests found by John J. Lynch averaged about 13 eggs. A clutch of 23 eggs was probably a dump nest. Several

investigators have reported incubation periods varying from 24 to 26 days. Nests were constructed of rice or other plants that occurred in the rice fields; they usually had a canopy and ramp; none was lined with down. Renesting compensated for some first attempt losses. Depredations on rice plantings sometimes occurred in spring in water-planted rice fields. Favorite foods were seeds of grasses and sedges found in rice fields. Flocks totalling 3000 were occasionally seen in the fall on the Lacassine Wildlife Refuge.

Literature Cited

Bailey, A. M.
1928 Notes on winter birds of Chenier au Tigre, Louisiana. *Auk*, 45:271–282.

Carroll, J. J.
1932 A change in distribution of the Fulvous Tree Duck (*Dendrocygna bicolor helva*) in Texas. *Auk*, 49:343–344.

Davis, W. T., P. W. Close and R. H. Imler
1944 Fulvous Tree-duck depredations on rice in Louisiana. Report in files of U. S. Fish and Wildlife Service.

Dawson, W. L.
1923 The birds of California (Vol. 4). San Diego, Los Angeles and San Francisco: South Moulton Co., 2122 pp.

Delacour, J.
1954 The waterfowl of the world (Vol. 1). London: Country Life, Ltd., 284 pp.

Imler, R. H., H. C. Gascon and C. L. Horner
1944 Fulvous Tree-duck depredations in rice in Louisiana. Report in files of U. S. Fish and Wildlife Service.

Johnstone, S. T.
1957 On breeding of whistling ducks. *Avic. Mag.*, 63:23–25.

Lowery, G. H.
1955 Louisiana birds. Baton Rouge: La. State Univ. Press, 556 pp.

Lynch, J. J.
1943 Fulvous Tree-duck in Louisiana. *Auk*, 60:100–102.

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COMMENTS ON "SPECIES RECOGNITION" WITH SPECIAL REFERENCE TO THE WOOD DUCK AND THE MANDARIN DUCK

BY WILLIAM C. DILGER AND PAUL A. JOHNSGARD

It is well known that closely related, sympatric species have evolved species-specific features which serve to minimize the possibility of "wrong" choices being made during pair formation. The amount of evolution of such species-specific features is roughly proportional to the deleterious effects of the "wrong" choices made in species recognition. Of course, if upon initial contact, the forms interbreed too freely panmixia will occur and both will eventually lose whatever genetic identity they may have had. On the other hand if, by the time of contact, the forms have incidentally developed differences sufficient to serve automatically as isolating mechanisms from the outset, then the further evolution of such characters will not occur as a result of "mistakes" being made. Thus, it would seem that the post-contact evolution of species-specific features which serve as isolating mechanisms depends upon rather particular conditions involving contacts between forms which find themselves neither impartially interfertile nor completely isolated at the start (see Sibley, 1957, for a thorough discussion of these phenomena).

The species recognition features evolved in birds are mainly visual and/or vocal in nature. Either may predominate, depending on the nature of the selection pressures involved and upon the nature of the genetic variability available upon which the selection can exert its influence. Visual recognition will tend to be emphasized by selection in those species in which visual features are most advantageous, and the same may be said for vocal features. The relative advantage or disadvantage is probably determined largely by the ease in which either may be perceived in the physical environment in which pair formation typically takes place (Dilger, 1956). Ducks of the genus *Anas*, many trochilids, paradiseids, phasianids, etc., probably rely largely on visual species recognition (Sibley, 1957); and thrushes of the genus *Catharus* have been shown to rely most heavily on vocalizations for their species recognition (Dilger, 1956).

The process of evolution of a signal character (visual, vocal, etc.) from a nonsignal origin is termed "ritualization." This term is used because it is rather descriptive of what happens to a movement as it evolves into having a greater and greater effect as a signal. Ethologists employ this term for the evolution of motor patterns (Blest, 1957 MS), but it should also apply to the evolution of associated structural features (shape, color, texture, etc.) which the motor patterns accentuate and which accentuate the motor patterns. This course seems reasonable because structural changes toward increasing signal

function exhibit the same phenomena characteristic of the ritualization of motor patterns.

It is necessary to emphasize that the same selective pressures which are responsible for ever refining and rendering more "unmistakable" the male signal characters are also working equally on the releasing mechanisms (RM's) of the female. These RM's are responsible for receiving (via the sense organs) the sign stimuli emanating from the male and, depending on the circumstances, translating these signals into varying combinations of effector (muscular and glandular) actions. Thus the females exhibit as much sexual "dimorphism" as the males do only it is not visible. The evolution of the RM ideally "keeps pace" with the continuing refinements of the signal to which it is attuned. In most cases it seems likely that the male signal characters and the female RM's do evolve roughly apace although it is unlikely that they evolve *exactly* together because of the probable disparity in the amount of genetic variability in the systems controlling the signal characters and the RM's.

Investigations into the mechanisms of species recognition should not only include consideration of the innate releaser-sign stimulus-RM features briefly discussed above, but should also include a consideration of possible effects of early experience in regard to various learning processes such as "imprinting" (*Pragung*) and allied phenomena. These are undoubtedly of great importance in some instances even though they may not always be as directly controlled genetically as are the purely innate mechanisms. If the critical features of the normal environment which serve as releasers, and which make up the *Umwelt* for each species, are rather rigid and "predictable" then the animal can "afford" to have its responses "built in," so to speak, in a rigid manner exemplified by the common releaser-sign stimulus-RM type of response. If, on the other hand, the animal's *Umwelt* is a rather plastic one in any regard, then the responses to this type of situation are likely to be learned in some fashion. Different types of learning (see Thorpe, 1951) will prevail, depending on the nature of the situation. Imprinting, characterized by a short "sensitive period" and relative stability once established, seems to be a type of learned response close to a purely innate type of response.

It has been long known that if hybrids are desired under laboratory conditions it is easier to obtain them if individuals of one of the two species with which one wishes to work are raised by the other species. Individuals thus reared seem to behave as if they had become imprinted on the foster parents and form pair bonds with members of the foster parent species much more easily than otherwise. The senior author has data indicating that this may be true within the genus *Agapornis*, for instance. Whitman (1919) utilized this technique with various pigeons and may have been the first to

discover this principle. It is equally well known, however, that in some species this early experience has apparently no effect on future behavior as far as "choosing" a mate is concerned. The Brown-headed Cowbird (*Molothrus ater*) and the Cuckoo (*Cuculus canorus*) are two examples in which the young are regularly raised by foster parents and which, as adults, have no trouble in choosing mates of the proper species. If imprinting is involved in such cases it would mean that the sensitive period does not occur until the young normally have contact with their own species. At any rate it seems that species recognition, like other behavior features, is dependent upon both innate and learned elements in various relative strengths and combinations, depending upon the nature and the amount of the selective pressures brought to bear. This would naturally vary from species to species. However, it does seem probable that parasitic species are the only ones in which early experience is likely to play no part in rendering the adults more likely to "choose" mates of their own species (see also Cushing, 1941).

The source of selection in developing species recognition features and their attendant RM's may be *any* of the many and biologically disadvantageous events attendant upon the formation of interspecific pairs (Dilger, 1956). In addition, it may be of importance to consider the circumstances under which "mistakes" may be made. There seem to be at least two such circumstances. One is a situation where a female is located geographically in such a manner that her own species is relatively rare and a closely related, or even a merely similar appearing or sounding, species is rather abundant. This is a situation that is common where two related species share a rather narrow zone of overlap. This female will display the usual appetitive behavior asociated with a "search" for a mate. The longer she searches in vain the lower her threshold to respond becomes. This threshold may become so lowered that she will eventually respond to the suboptimal stimuli afforded by the next most similar set of sign stimuli, which will most likely be a male of the next most closely related species. Selection may work on such species as this to either restrict its range to areas in which the conflicting stimuli do not exist or to further refine the male signal characters and the female RM's to function in a signal spectrum even farther from that of the related species. In this latter case, the related species will also evolve its signal characters and RM's farther away from its "competitor." The other situation is where a female has an unspecific set of RM's resulting from an unfortunate genetic recombination or, possibly, because of a mutation causing her to react unspecifically to male signals. Males may also have unspecific signals caused by the same phenomena. This situation, of course, will be selected against possibly even more strongly as these birds would be prone to make "mistakes" chronically in the case of females or be not as likely to attract mates in the case of males.

It has been suggested (Sibley, 1957) that those sympatric, closely related species which are polygamous and exhibit short term pair bonds demonstrate the most pronounced species recognition signal characters. The reason suggested is that "the combined effects of selection against hybrids and of sexual selection should produce a high degree of species diversity and development of signal characters in the males" (and a high degree of species diversity and development of the RM's in the females). This is quite likely to be true. However, there are many closely related and sympatric species (such as some parrots, for instance) which are not polygamous and which form pair bonds of long duration—perhaps for many years. These species also evolve highly diverse species characters. If a "mistake" is made by individuals of these species it will tend to be of long duration and will likewise tend to cause a consequent high degree of "damage" to the gene pools involved. Hence, selective pressures brought to bear in these cases would also be very strong ones and would also result in a high degree of species diversity in regard to signal characters and RM's. The parrot genera *Amazona* of the New World and *Psittacula* of the Old World provide likely examples of this.

Not only does the length of the pair bond seem to have an influence upon the nature of the selective pressures brought to bear, but the time it takes the bond to form is probably of importance as well. Some thrushes, which have a seasonal pair bond, take three to four days to form their pair bonds (Dilger, 1956), and ducks commonly require several months to form their pair bonds, but Budgerigars (*Melopsittacus undulatus*), which have pair bonds lasting for years, take but a few hours to form them (Morris, 1956). Budgerigars do not have the problem of existing sympatrically with closely related species, but the thrushes and ducks considered do. In some cases it might be an advantage to have evolved behavior patterns which cause the pair bond to be formed rather slowly where mistakes are likely to be made.

The most effective species-recognition insurance may occur in species having strong parental imprinting overlying innate behavior, militating for a long pair bond formation period and highly evolved signal characters with their associated RM's. These modifications which may evolve as isolating mechanisms probably occur in various combinations and strengths depending again on the vicissitudes of the selection pressures involved and upon the genetic variability available.

From our human viewpoint we naturally tend to think of these as problems of species recognition. However, if we try to project ourselves into the bird's *Umwelt* and regard these problems from its "viewpoint," a slightly different slant is obtained which may be of use to our thinking. Birds apparently are incapable of having concepts of any kind, including those of "sex," "species," "male," "female," etc. The bird's "problem" becomes one of culminating a

period of appetitive behavior with the perception of sign stimuli which, in a broad sense, triggers the initiation of a "satisfactory" sexual association. It is of value if we are aware of this "bird's eye view" because it may give us a much better idea of what is important to the animals concerned and thus may give us a better idea of how and where selection is working. The major reason why birds, like most other animals, make "mistakes" is that they do not react to the total environment but only to those features to which they have evolved to react under particular circumstances. This is why they are so easily misled experimentally by what may seem to many as totally improbable objects (see Tinbergen, 1951). The observed instances of this are many, but Lack's (1953) Robins (*Erithacus rubecula*), fighting a tuft of red feathers, or Tinbergen's (1951) male sticklebacks (*Gasterosteus aculeatus*), reacting aggressively to any red object, have become classic examples. The senior author has found that Wood Thrushes (*Hylocichla mustelina*) will mount and attempt coition with *papier mâché* models of Wood Thrushes (Dilger, 1956), and these same birds will react aggressively or otherwise to small cubes and spheres painted brown above and white with black spots below.

An apparent evolutionary anomaly is the existence of the Wood Duck (*Aix sponsa*) and the Mandarin Duck (*A. galericulata*). The males of both species seem literally covered from head to tail with the most improbable and complicated collection of highly specific releasers that one could imagine, yet these species are not sympatric with any closely related ones or with each other. Like all highly evolved social signals, these are likely to be strongly selected against by predation if they are not even more strongly selected for by the necessity of ready recognition by females of their own species. This would seem to suggest the possible explanation that these species were sympatric with each other or with closely related forms in the near past. However, the only near relative of the Wood Duck which possibly could have been recently sympatric with it is the Muscovy (*Cairina moschata*) of Mexico, and it is a significant fact that hybrids between these two forms are unknown. Likewise, the Mandarin has possibly been sympatric only with the fairly closely related Pigmy Goose (*Nettapus coromandelianus*), a combination for which hybrids are also unknown. If indeed some closely related form had been sympatric with either the Wood Duck or the Mandarin in the past one would think that selection operating through the effects of predation would have caused the males to tend toward a more cryptic plumage since the time of species separation. This is evidently not the case.

Another thought is that ducks of other less closely related genera, and possibly even of other tribes, may be the source of selective pressures if sufficient "mistakes" in mate choices are made that involve these more distant relatives. There is considerable support for this supposition. The Wood Duck is

notorious for forming mixed pairs and has produced hybrids with 26 species of ducks (Johnsgard, MS). Species involved include such unlikely forms as the Common Shelduck (*Tadorna tadorna*), 16 species of *Anas*, and five species of *Aythya*. This would indicate a very high first generation chromosomal compatibility, exceeded only by the Mallard (*Anas platyrhynchos*), which has hybridized with 40 species of Anatidae. It is of significance that the majority of Wood Duck hybrids of known parentage have involved the female Wood Duck, whereas most Mallard hybrids result from the male Mallard copulating with females of other species.

The hybrids produced by Wood Ducks and Mandarins are apparently always sterile, and although they have been reported only from birds in captivity, these facts do demonstrate the Wood Duck's unusual proclivity for mixed pairing. Mandarins, on the other hand, are not known to have hybridized with more than five other species. Paradoxically, the two species of *Aix* will only rarely, if ever, hybridize with each other. The remarkable findings of Yamashina (1952), which indicate that the Mandarin possesses two less chromosomes than the Wood Duck and other anatines, would provide a logical explanation for sterility in alleged Mandarin × Wood Duck hybrids, and may also explain the former's failure to hybridize with as many species as has the Wood Duck.

Even in view of this extensive mixed pairing it is difficult to explain why the males of *Aix* have evolved such extreme complexities of plumage patterns. The danger of mixed pairs being formed within the genus *Anas*, for example, is equally great, and the male dimorphism exhibited here is extensive—not enormous as it is in *Aix*. Perhaps intertribal pairings are selected against more strongly than are intergeneric ones, but also the elaborate display movements of *Anas* probably substitute in large part for the very elaborate display plumage of *Aix*.

Another, at least partial, explanation may lie in the possible discrepancy between the evolution of the male signal characters and the female RM's. If for some reason, such as a lack of enough genetic variability, the females were not able to evolve a sufficiently refined set of RM's rapidly enough, the greatest part of the burden of selective pressures toward species recognition would fall on the males, resulting in the extreme plumage complex we observe at present.

Perhaps the fact that Wood Ducks, and especially Mandarins, are crepuscular in their habits (Heinroth, 1910*b*, and Savage, 1952) is related to the increased danger of predation from visually operating predators attracted by the showy male plumages. Mandarins are in fact even more crepuscular than Wood Ducks. This may be related to their greater elaboration of contrasting male plumage patterns.

Aix males are also more highly competitive with each other over the attentions of females than are most other ducks. In both species, but particularly the Mandarin, the males congregate around a receptive female and conduct their courtship displays in a highly intense and competitive manner (Lorenz, 1941, and Heinroth, 1910*a*). This may indicate that there is a comparatively great amount of competition among the males in displaying the optimal stimuli to a female. Although Mandarins appear to be monogamous with long pair bonds (in the wild at least), this initial intraspecific sexual competition and a greatly extended period of display and pair formation must be effective in maintaining the high degree of sexual dimorphism found in this species. This is especially true in the Mandarin, where the choice of a mate lies exclusively with the female (Lorenz, 1941). Selection thus would tend to cause the males to evolve releasers of ever increasing effectiveness. This may perhaps be thought of as an "attempt" to evolve a kind of superoptimal set of stimuli. An additional point of interest is that the males of *Aix* (especially *sponsa*) have displays consisting of numerous primitive and simple actions (Lorenz, 1941) which are largely homologous with the elaborate displays of *Anas*; thus possibly *Anas* males provide a kind of superoptimal stimulation to the RM's of *Aix* females. This may explain the disproportionate frequency of matings with *Anas* males. It has been proven that birds and other animals will often react more strongly to superoptimal stimuli even though these usually do not occur in nature and are manufactured by the experimenter (Koehler and Zagarus, 1937, and Tinbergen, 1951, for example).

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Summary

Several things are pointed out that should be considered by anyone interested in problems of "species recognition." These are:

1. The source of selection controlling development of species-specific signals and releasing mechanisms (RM's) may be *any* of the disadvantageous consequences of mixed pairing (not necessarily hybridization alone).
2. The term "ritualization" should apply equally to the evolution of morphological features and motor patterns which are being selected for toward increasing signal function.
3. It should be remembered that the evolution of RM's proceeds in concert with that of the associated signal characters.
4. Early experience resulting in some form of learning such as "imprinting" may be of considerable consequence in subsequent "species recognition."
5. The reasons why mistakes may be made in "mate choice" should be considered. For example, genetically "normal" animals may respond to suboptimal stimuli because of abnormally lowered thresholds; or genetically "abnormal" animals may respond with unrefined response capabilities.
6. Sympatric, closely related species which are polygamous and which have short term pair bonds are not the only ones upon which strong selective pressures exert their influence toward marked development of signal characters and RM's. Consider closely related, sympatric species with very long pair bonds which are not polyga-

mous such as some of the parrots, etc.

7. Closely related species which are sympatric may not be the only source of selection toward diverse signals and RM's. Any species with somewhat similar signal features and RM's may exert this influence providing that they, of course, are sympatric with the form under investigation.
8. The amount of time taken to form the pair bond as well as its duration is likely to be of importance (*Aix*, for example).
9. It is useful to try to think of these problems from the "bird's point of view." After all, these problems are functions of the animal's *Umwelt*—not ours!

Literature Cited

Blest, A. D.
1957 MS The concept of ritualisation.

Cushing, J. E.
1941 Non-genetic mating preference as a factor in evolution. *Condor*, 43:233–236.

Dilger, W. C.
1956 Hostile behavior and reproductive isolating mechanisms in the avian genera *Catharus* and *Hylocichla*. *Auk*, 73:313–353.

Heinroth, O.
1910*a* Beobachtungen bei einem Einbürgerungsversuch mit der Brautente (*Lampronessa sponsa* [L.]). *Jour. f. Ornith.*, 59:101–156.
1910*b* Beiträge zur Biologie, namentlich Ethologie und Psychologie der Anatiden. *Verh. V. Ornith. Kong.* (Berlin), 1910:589–702.

Johnsgard, P. A.
1956 MS Hybridization in the Anatidae and its taxonomic implications.

Koehler, O. and A. Zacarus.
1937 Beiträge zum Brutverhalten des Halsbandregenpfeifers (*Charadrius h. hiaticula* L.). *Beitr. Fortpfl. biol. Vögel*, 13:1–9.

Lack, D.
1953 The life of the robin. London: Pelican Books, 240 pp.

Lorenz, K.
1941 Vergleichende Bewegungsstudien an Anatinen. *Jour. f. Ornith.*, 89:194–293.

Morris, R.
1956 Mating behaviour of the budgerigar. *Cage Birds*, 110:299–300.

Savage, C.
1952 The mandarin duck. London: Adam and Charles Black, 78 pp.

Sibley, C.
1957 The evolutionary and taxonomic significance of sexual dimorphism and hybridization in birds. *Condor*, 59:166–191.

Thorpe, W.
1951 The learning ability of birds. *Ibis*, 93:1–52, 252–296.

Tinbergen, N.
1951 The study of instinct. Oxford: Clarendon Press, 228 pp.

Whitman, C.
1919 The behavior of pigeons. *Carnegie Inst. Wash.*, publ. 257. 3:1–161.

Yamashina, Y.
1952 Classification of the Anatidae based on the cyto-genetics. *Papers from the coordinating committee Res. Genetics*, 3:1–34.

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VARIATION IN THE SONGS OF THE RUFOUS-SIDED TOWHEE

BY DONALD J. BORROR

Considerable variation is known to occur in Rufous-sided Towhee (*Pipilo erythrophthalmus*) songs (Saunders, 1951), but relatively little is known of the exact nature of the variation. This study was made to learn more of the nature of the variation in the songs of this bird.

The collection of tape recordings in the Laboratory for the Study of Animal Sounds, Department of Zoology and Entomology, Ohio State University, includes 71 recordings containing towhee songs (43 from Ohio, 4 from Michigan, 13 from Maine, 2 from West Virginia, 3 from North Carolina, and 6 from Florida); these recordings contain a total of 694 songs (Tables 1 and 7). These songs have been analyzed by means of a Vibralyzer (Borror and Reese, 1953), and graphs made of the different patterns found. Most of the recordings were made by the writer; a few were made by Dr. Carl R. Reese. All the recordings were made with a Magnemite Model 610-E tape recorder, using a tape speed of 15 inches per second.

General Character of Towhee Songs

Towhee songs commonly consist of two parts, (1) one or more introductory notes, and (2) a trill. A few songs lack the first part, a few lack the second part, and a few are double (introductory notes, a trill, then more introductory notes, then another trill). The trill usually consists of a rapid series of similar phrases; occasionally the first note or phrase of the trill is different from the rest, and in rare cases the trill is two-parted (a few phrases of one type, then a few of another type). Each part may vary in the number and character of the notes or phrases it contains.

A towhee generally sings at the rate of five to ten songs a minute. Its songs are usually all alike, but it may occasionally sing songs of one type for a while, and then change to a different type; rarely a bird may sing two types of songs alternately. The largest number of song types recorded from a single bird in a single recording was eight (recording No. 879B, from Florida).

Variation in Introductory Notes of Song

The introductory notes in the songs studied represented 45 different patterns (plus one other in which there were *no* introductory notes). These patterns were designated by capital letters, A through TT, and may be classified as follows:

I. With no introductory notes (designated as pattern A)

II. With one introductory note (12 patterns, B–M)
   a. The note clear and musical (5 patterns, B–F, Figs. 1, 9–12, and one note like those in Fig. 46)
   b. The note buzzy (5 patterns, G–K, Figs. 2, 13–17)
   c. The note with both musical and buzzy elements (2 patterns, L–M, Figs. 18–19)

III. With two introductory notes (23 patterns, N–JJ)
   a. The two notes about the same pitch (5 patterns, N–R, Figs. 3, 20–22, and two notes like those in Fig. 46)
   b. The first note higher in pitch than the second (12 patterns, S–DD, Figs. 4–6, 23–39)
   c. The second note higher in pitch than the first (6 patterns, EE–JJ, Figs. 7, 40–45)

IV. With three introductory notes (8 patterns, KK–RR)
   a. The three notes alike (1 pattern, KK, Fig. 46)
   b. The first two notes alike, the third different (2 patterns, LL–MM, Figs. 47–48)
   c. All three notes different (5 patterns, NN–RR, Figs. 8, 49–53)

V. With four introductory notes (2 patterns, SS–TT)
   a. The four notes alike (1 pattern, SS, the notes like those in Fig. 46)
   b. The four notes different (1 pattern, TT, Fig. 54)

The occurrence of these introductory patterns in the recordings from different areas is summarized in Table 2.

One Introductory Note.—Nearly one-fourth of the introductory patterns found consisted of a single note. When this note was musical, it was steady in pitch (Figs. 1, 9, and 10), slightly up-slurred (Fig. 11), abruptly down-slurred (like the notes in Fig. 46), or down-slurred at the beginning and then steady in pitch (Fig. 12). When it was buzzy, it was up-slurred (resembling the "chewink" call, Figs. 2, 15), or steady in pitch (Figs. 14, 16, and 17). The introductory note in one Ohio pattern (pattern L) was buzzy at the beginning, then musical and nearly steady in pitch (Fig. 18); in one Florida pattern (pattern M) it was abruptly down-slurred and then buzzy (Fig. 19).

Two Introductory Notes.—Half of the introductory patterns found consisted of two notes. These notes were alike in four patterns (2 from Florida, 1 from Maine, and 1 from central Ohio, Figs. 3, 21, 22, and like two of the notes in Fig. 46), and slightly different in quality but of about the same pitch in one Florida pattern (Fig. 20). The most common type of introduction (12 patterns) consisted of a high-pitched note and a lower-pitched note; in most of these (Figs. 4, 23–32) the first note was shorter and sharper than the second, with the second musical; in a few cases (Figs. 5, 33, and 34) the first note was buzzy; in a few other cases (Figs. 36–39) the first note was complex, containing two dominant frequencies or containing two or more overlapping notes; in one pattern (Figs. 6, 35) the two introductory notes overlapped.

Three or Four Introductory Notes.—These patterns made up a little over one-fifth of the total. Most of the introductory patterns consisting of three notes (Figs. 8, 49–53) had these notes different.

Twelve of the introductory patterns (excluding pattern A, representing no introductory notes) occurred in the songs of different birds; the occurrence of these patterns is summarized in Table 3. One pattern (V, Figs. 27–29) occurred in as many as seven different birds; several patterns occurred in birds from widely separated areas.

TABLE 1

RUFOUS-SIDED TOWHEE SONG RECORDINGS STUDIED

Recording					Figure No.[2]		
No.	Locality	Date	Series[1]	Song Pattern	Introd.	Trill	No. of Songs
342	Bradenton, Florida	March 24, 1953	—	FF-31	41	83	5
384	Franklin Co., Ohio	April 10, 1953	A	F-22	(12)	(75)	3
			B	NN-33	49	(85)	2
432	Columbus, Ohio	April 29, 1953	—	OO-46	50	99	9
457	Reynoldsburg, Ohio	May 4, 1953	—	OO-37	8	8	7
665	Worthington, Ohio	May 30, 1953	—	II-44	44	97	10
762	Reynoldsburg, Ohio	March 24, 1954	A	C-39	(10)	92	10
			B	C-47	(10)	101	1
766	Reynoldsburg, Ohio	March 24, 1954	—	C-18	1	1	11
786R	Columbus, Ohio	April 21, 1954	—	V-38	(27)	91	9
814B	Bradenton, Florida	April 6, 1954	A	Q-1	(3)	—	1
			B	Q-4	3	3	21
879B	Myakka River State Park, Florida	April 13, 1954	A	A-27	—	80	5
			B	E-27	(46)[3]	(80)	1
			C	O-27	(46)[3]	(80)	5
			D	KK-27	(46)	(80)	1
			E	N-6	20	(59)	1
			F	M-6	19	59	11
			G	KK-1	46	—	3
			H	SS-1	(46)[3]	—	1
912B	Greensboro, N. C.	April 24, 1954	—	PP-15	51	68	8
916B	Greensboro, N. C.	April 24, 1954	A	Y-1	(33)	—	1
			B	Y-28	33	81	11
921B	Greensboro, N. C.	April 24, 1954	—	GG-5	42	57	10
1127	Hocking Co., Ohio	June 5, 1954	—	G-47	13	(103)	8
1262	New Albany, Ohio	April 1, 1955	—	MM-23	48	76	11
1284	New Albany, Ohio	April 10, 1955	A	F-21	12	74	2
			B	U-47	26	(102)	7
1296	Columbus, Ohio	April 13, 1955	—	HH-49	(43)	107	6
1299	Columbus, Ohio	April 14, 1955	A	U-32	25	84	9
			B	U-8	(25)	61	8
1433	Worthington, Ohio	May 19, 1955	—	II-49	(44)	(107)	9
1464	Adams Co., Ohio	May 30, 1955	—	HH-49	7	7	15
1471	Hocking Co., Ohio	June 5, 1955	A	L-1	18	—	3
			B	A-12-2	—	65, 55	3
1550B	Lincoln Co., Maine	July 19, 1955	—	C-26	(10)	79	8
1557B	Lincoln Co., Maine	July 23, 1955	A	W-34	(31)	86	3
			B	W-43	(31)	96	10

TABLE 1 (*Continued*)

Recording No.	Locality	Date	Series[1]	Song Pattern	Figure No.[2] Introd.	Trill	No. of Songs
1560B	Lincoln Co., Maine	July 23, 1955	—	B-34	(9)	(86)	11
1641B	Bradenton, Florida	March 14, 1956	—	Z-3	34	56	1
1649	New Albany, Ohio	March 27, 1956	A	LL-24	47	77	6
			B	OO-29	(50)	82	10
1728	Reynoldsburg, Ohio	April 28, 1956	A	F-1	(12)	—	1
			B	F-47	(12)	105	7
1731	Reynoldsburg, Ohio	April 28, 1956	A	JJ-1	(45)	—	11
			B	JJ-47	45	(103)	2
1734	Reynoldsburg, Ohio	April 28, 1956	—	DD-36	38	90	11
1786	New Albany, Ohio	May 5, 1956	A	U-24	(25)	(4)	2
			B	T-47	24	102	2
1808	Reynoldsburg, Ohio	May 6, 1956	—	U-24	4	4	11
1823	New Albany, Ohio	May 9, 1956	A	A-46	—	(100)	5
			B	A-46-46	—	(100)	10
1826	New Albany, Ohio	May 9, 1956	—	EE-14	40	67	6
1955	Reynoldsburg, Ohio	May 30, 1956	—	C-18	(10)	(71)	11
1958	Reynoldsburg, Ohio	May 30, 1956	—	CC-35	37	88	7
1971	Adams Co., Ohio	June 2, 1956	A	F-28	(12)	(81)	2
			B	F-22	(12)	75	1
1991	Hocking Co., Ohio	June 2, 1956	—	U-24	(25)	(77)	8
2109	Lincoln Co., Maine	July 1, 1956	—	W-34	30	(86)	11
2112	Lincoln Co., Maine	July 1, 1956	—	C-7	(10)	(60)	3
2205	Lincoln Co., Maine	July 19, 1956	—	C-7	(10)	60	12
2207	Lincoln Co., Maine	July 19, 1956	A	TT-16	54	69	4
			B	QQ-16	52	(69)	2
2213	Lincoln Co., Maine	July 25, 1956	A	V-30	(28)	(2)	5
			B	I-11	(2)	64	2
			C	I-30	2	2	3
2215	Lincoln Co., Maine	July 25, 1956	A	C-20	(10)	73	13
			B	X-34	5	5	2
			C	A-34	—	(5)	1
			D	C-34	10	(5)	2
2357	Collier Co., Florida	March 21, 1957	—	J-41	(16)	(94)	8
2390	Collier Co., Florida	March 21, 1957	—	J-41	16	94	6
2445	New Albany, Ohio	April 11, 1957	—	HH-50	(43)	110	5
2457	New Albany, Ohio	April 16, 1957	—	F-50	(12)	111	10

TABLE 1 (*Continued*)

Recording			Series[1]	Song Pattern	Figure No.[2]		No. of Songs
No.	Locality	Date			Introd.	Trill	
2458	New Albany, Ohio	April 16, 1957	—	F-50	(12)	(111)	9
2459	New Albany, Ohio	April 16,1957	A	HH-50	(43)	(112)	7
			B	HH-49	(43)	108	2
2460	New Albany, Ohio	April 16, 1957	—	AA-47	6	6	8
2463	New Albany, Ohio	April 16, 1957	—	DD-5	39	58	9
2476	New Albany, Ohio	April 24, 1957	A	B-18	9	(71)	12
			B	P-51	21	113	2
2486	New Albany, Ohio	April 27, 1957	—	H-18	14	71	13
2488	New Albany, Ohio	April 27, 1957	—	AA-47	(6)	104	10
2489	New Albany, Ohio	April 27, 1957	—	V-53	28	115	5
2497	New Albany, Ohio	April 27, 1957	—	HH-50	43	112	14
2499	Reynoldsburg, Ohio	April 28, 1957	—	D-42	11	95	8
2520	Whitehall, Ohio	May 1, 1957	—	U-25	(25)	78	11
2578	Reynoldsburg, Ohio	May 7, 1957	—	V-19	29	72	8
2587	Columbus, Ohio	May 10, 1957	A	AA-47	35	103	7
			B	B-46	(9)	100	11
			C	I-48	15	106	9
2666	Worthington, Ohio	May 18, 1957	—	RR-35	53	89	2
2706	Kanawha City, W. Va.	May 25, 1957	—	S-33	23	85	6
2715	Kanawha City, W. Va.	May 25, 1957	A	C-9	(10)	62	3
			B	C-9-H-17	(10, 14)	(62), 70	4
2757	Oscoda Co., Mich.	May 30, 1957	A	BB-1	(36)	—	2
			B	BB-13	36	66	5
2770	Oscoda Co., Mich.	May 31, 1957	—	V-52	27	114	6
2781	Oscoda Co., Mich.	May 31, 1957	—	V-45	(27)	98	12
2782	Oscoda Co., Mich.	May 31, 1957	—	K-54	17	116	7
2941	Lincoln Co., Maine	July 3, 1957	—	W-50	31	109	10
2945	Lincoln Co., Maine	July 13, 1957	—	W-10	(31)	63	10
3000	Lincoln Co., Maine	July 14, 1957	—	V-34	(28)	(86)	12
3002	Lincoln Co., Maine	July 14, 1957	A	R-34	22	87	3
			B	W-40	32	93	4
			C	W-1	(32)	—	1

[1] Series are designated only in recordings containing songs of two or more patterns.
[2] Numbers in parentheses represent figures of this pattern, but were made from a song in another series.
[3] Patterns E, O, and SS are like pattern KK (Fig. 46), but contain one, two, and four notes respectively, instead of three.

Table 2

Occurrence of the Introductory Patterns in Towhee Songs

Pattern Group[1]	Number of Patterns							
	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total[2]
I	1	1		1			1	1
II a	4	1		2	1		1	5
II b	2	1	1	1	1		1	5
II c		1					1	2
III a	1			1			3	5
III b	6	1	2	3	1	1	1	12
III c	4	1				1	1	6
IV a							1	1
IV b	2							2
IV c	3			1		1		5
V a							1	1
V b				1				1
Total[3]	23	6	3	10	3	3	11	46

[1] Roman numerals and small letters refer to the groups in the classification outlined on p. 55.
[2] Some patterns occur in the songs of birds from different areas.
[3] Includes the pattern of **no** introductory notes.

Table 3

Introductory Patterns Occurring in the Songs of More Than One Bird

Pattern and Group[1]	Number of Birds in Which the Pattern Occurred							
	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
II a B	2			1				3
II a C	2			3	1			6
II a F	3	1						4
II b H	1				1			2
II b I	1			1				2
III b U	4	1						5
III b V	3		2	2				7
III b W				3				3
III b DD	2							2
III c HH	3	1						4
III c II	2							2
IV c OO	3							3

[1] Roman numerals and small letters refer to the groups in the classification outlined on p. 55; the capital letters refer to individual introductory patterns.

Variations in the Trill

The songs studied contained 53 different trill patterns (designated by numbers, 1–54, with No. 1 representing no trill); there was more variation in the trill than in the introductory part of the song. Even in the songs of different birds considered to have trills of the same pattern, there were minor variations (compare Figs. 5, 86, and 87; 101–105; 107 and 108; and 109–112) in the trill.

The different trill patterns differed in the general character of the phrases (number and types of notes present), their length (or the rate with which they were uttered), their number, and in how the trill began. The first phrase of the trill in 23 of the patterns was different from the remaining phrases, that is, the trill began with an extra note (Figs. 2, 4, 8, 60–63, 65, 66, 68, 75–79, 81, 82, 91, 93, 96, 99–101, 115, and 116); this note was sometimes very short (0.05 sec. or shorter), but in most cases it was longer than any of the subsequent trill phrases, and higher in pitch.

The variations in the trill were such that the different trill patterns were not readily classifiable. The phrases contained from one to several notes, and the notes frequently overlapped. Some of the characteristics of the trill patterns occurring in the songs of birds from different areas are summarized in Table 4. Songs of a given type sung by a given bird occasionally differed by one or a few phrases in the number of phrases in the trill; these differences were not considered to represent different trill patterns. Songs containing different types of trills often differed considerably in the number of trill phrases they contained, and in the rate with which the phrases were uttered.

Table 4

Summary of Trill Characteristics

Area	No. of Song Series	No. of Trills[1]	Trill Phrase Length (in seconds)		Number of Trill Phrases		
						Series Averages	
			Range	Average[2]	Range	Range	Average[2]
Central Ohio	48	375	.05–.20	.095±.004	2–15	2.78–14.32	7.36±0.34
Southern Ohio	7	38	.05–.12	.081±.012	2–10	3.33–10.00	6.29±0.85
Michigan	4	30	.11–.13	.120±.004	2–6	2.80–5.86	4.69±0.66
Maine	21	143	.03–.13	.072±.006	4–18	4.00–17.42	9.41±0.90
West Virginia	4	17	.06–.12	.088±.016	4–7	5.00–7.00	5.80±0.45
North Carolina	3	29	.04–.08	.063±.012	8–16	8.91–15.38	11.61±1.94
Florida	9	65	.05–.17	.092±.012	3–14	3.00–9.90	7.83±0.74
Total	96	697	.03–.20	.088±.003	2–18	2.78–17.42	7.73±0.31

[1] This is not quite the same as the number of songs, since some songs had no trill and some had two trills.

[2] Averages are given plus or minus the standard error of the mean; the figures in the last column are averages of the series averages.

The trill phrases varied in length from 0.03 (pattern 10, Fig. 63) to 0.20 sec. (pattern 48, Fig. 106), and were uttered at rates from 5 to about 35 phrases per second; they varied in number from 2 to 18. The trill phrases in the songs of Michigan birds averaged significantly longer than in birds from Ohio, Maine, and North Carolina; those in the songs of central Ohio birds averaged significantly longer than in birds from Maine. The number of trill phrases averaged significantly greater in the songs of birds from Maine than in the birds from Michigan and West Virginia, greater in the birds from North Carolina than in those from Michigan and West Virginia, and greater in the birds from central Ohio than in those from Michigan. In general, the shorter the trill phrases, the more phrases there were.

The trill phrases were generally all of the same pitch; rarely the pitch appeared to fall a little toward the end of the trill, usually because of the dropping out of some of the higher frequencies. The last phrase of the trill was occasionally incomplete. The trill often became less loud toward the end. When the trill began with a high-pitched buzz (for example, pattern 24, Fig. 4), this buzz was much louder than the rest of the trill.

Twelve trill patterns (excluding pattern 1, representing no trill) occurred in the songs of different birds (Table 5). Most of these recurring patterns occurred in only two or three birds; one (No. 47, Figs. 6, 101–105) occurred in six birds. Many of these patterns occurred in the songs of birds in widely separated areas.

TABLE 5

TRILL PATTERNS OCCURRING IN THE SONGS OF MORE THAN ONE BIRD

Trill Pattern	Number of Birds in Which the Pattern Occurred							
	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
5	1					1		2
18	3							3
22	1	1						2
24	2	1						3
28		1				1		2
33	1				1			2
34				2				2
35	2							2
46	3							3
47	5	1						6
49	3	1						4
50	2			1				3

Song Patterns

The combination of a particular type of introduction (A to TT) and trill (1 to 54) resulted in a particular song pattern (for example, B-18, K-54, and SS-1). A total of 93 song patterns were found in the recordings studied. These patterns are most easily classified on the basis of the type of introduction they contained. The occurrence of the 93 patterns in the songs of birds in different areas is summarized in Table 6.

Although there were 12 introductory patterns and 12 trill patterns that occurred in the songs of different birds, there were only 5 *song* patterns that were sung by different birds:

(1) Pattern F-22, sung by a bird in central Ohio (recording 384, series A) and another in southern Ohio (recording 1971, series B).

(2) Pattern U-24, sung by two birds in central Ohio (recording 1786, series A, and recording 1808, Reynoldsburg) and one in southern Ohio (recording 1991).

(3) Pattern AA-47, sung by two birds in central Ohio (recording 2460, and recording 2587, series A).

(4) Pattern HH-49, sung by two birds in central Ohio (recording 1296, Columbus, and recording 2459, series B, New Albany) and another in southern Ohio (recording 1464).

(5) Pattern HH-50, sung by two birds in central Ohio[1] (recordings 2459, series A, and 2497, and recording 2445).

There is a great deal of difference in the song pattern of different birds, and only rarely (in this study, only 5 of 93 song patterns) does one find a given song pattern sung by different birds. When the song patterns of different birds are sufficiently different to be distinguishable by ear, the individual birds can be recognized by their songs.

The songs of the Florida birds were somewhat different in character from those of the northern birds; none of the introductory or trill patterns of the Florida birds (except those of *no* introduction or trill) occurred in the songs of any northern birds (Tables 3 and 5). Most songs of the Florida birds are readily distinguishable by ear from those of northern birds.

There was an appreciable time interval between the notes of the introduction (when the introduction contained more than one note), and between the introduction and the trill. The time interval between the notes of the introduction is shown by the graphs (Figs. 3–8 and 20–54). The interval between the introduction and the trill (shown only in Figs. 1–8) varied in the different patterns from 0.04 to 0.30 sec., and averaged 0.12 sec.

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[1] There is a slight possibility that these recordings were of the same bird. Recordings 2459 and 2497 were made about fifty yards (and eleven days) apart; 2445 was made about one-fourth mile away, and five days before the first of the other two recordings was made.

Table 6

Occurrence of Towhee Song Patterns

Pattern[2]		Number and Per Cent of Song Patterns[1]							
		Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
I		2 4.65	1 14.29		1 5.00			1 7.14	5 5.38
II	a	11 25.58	2 28.57		5 25.00	2 66.67		1 7.14	20[3] 21.51
	b	2 4.65	1 14.29	1 20.00	2 10.00			1 7.14	7 7.53
	c		1 14.29					1 7.14	2 2.15
	Tot.	13 30.23	4 57.14	1 20.00	7 35.00	2 66.67		3 21.43	29[3] 31.18
III	a	1 2.33			1 5.00			5 35.71	7 7.53
	b	13 30.23	1 14.29	4 80.00	9 45.00	1 33.33	2 50.00	1 7.14	30[3] 32.26
	c	7 16.28	1 14.29				1 25.00	1 7.14	9[3] 9.68
	Tot.	21 48.84	2 28.57	4 80.00	10 50.00	1 33.33	3 75.00	7 50.00	46[4] 49.46
IV	a							2 14.29	2 2.15
	b	2 4.65							2 2.15
	c	5 11.63			1 5.00		1 25.00		7 7.53
	Tot.	7 16.28			1 5.00		1 25.00	2 14.29	11 11.83
V	a							1 7.14	1 1.07
	b				1 5.00				1 1.07
	Tot.				1 5.00			1 7.14	2 2.15
Total		43 46.24	7 7.53	5 5.38	20 21.51	3 3.22	4 4.30	14 15.05	93[5]

[1] The upper figure is the number of song patterns, and the lower figure is the per cent of the patterns from that area; in the bottom line, under "Total," the per cent is the per cent of all the patterns (93) occurring in the songs of birds from that area.
[2] Roman numerals and small letters refer to the groups in the classification outlined on p. 55.
[3] One of these patterns occurred in the songs of birds from two different areas.
[4] Two of these patterns occurred in the songs of birds from two different areas.
[5] Three of these patterns occurred in the songs of birds from two different areas.

The frequencies in the towhee songs studied (excluding harmonics) were for the most part between 2000 and 6000 cycles per second. The extremes found were 1800 cycles per second (patterns DD and MM, Figs. 39 and 48) and 9000 cycles per second (pattern 36, Fig. 90).

Table 7

Summary of the Towhee Recordings Studied

Number of	Central Ohio	Southern Ohio	Michigan	Maine	West Virginia	North Carolina	Florida	Total
Birds Recorded[1]	27	5	2	7	2	3	5	51
Recordings	38	5	4	13	2	3	6	71
Song Series[2]	51	7	5	22	3	4	14	106
Songs	377	40	32	132	13	30	70	694
Introductory Patterns[3]	22	5	3	9	3	3	10	45[4]
Trill Patterns[3]	27	7	4	11	3	3	6	53[4]
Song Patterns[3]	43	8	5	20	3	4	14	93

[1] An estimate; represents a minimum figure.
[2] A song series is a group of songs of a given pattern in a given recording.
[3] Some of these patterns occurred in the songs of birds from more than one area.
[4] Does not include the pattern of **no** introduction or trill.

Summary

The songs of the Rufous-sided Towhee usually consist of one or more introductory notes and a trill. In 71 tape recordings of towhee songs, from six states (Ohio, Michigan, Maine, West Virginia, North Carolina, and Florida) and containing 694 songs, there were 45 introductory patterns (plus one of *no* introductory notes) and 53 trill patterns (plus one of *no* trill). The introductory patterns contained from one to four notes. The trills contained from 2 to 18 phrases, uttered at rates f 5 to 35 phrases per second. The different introductory and trill patterns were combined in 93 different song patterns (Table 7). The recordings were studied by means of a Vibralyzer. The song patterns were classified on the basis of their introductory notes. Twelve introductory patterns and 12 trill patterns, but only 5 song patterns, were found in the songs of different birds. The frequencies in the songs ranged from 1800 to 90000 cycles per second, but in most songs were between 2000 and 6000 cycles per second.

There is a great deal of variation in towhee songs, and more variation in the trill than in the introductory notes. It is possible in many cases to recognize individual birds by their song.

Plate 1. Audiospectrographs of Towhee Songs. Fig. 1, pattern C-18, 766-1, central Ohio. Fig. 2, pattern I-30, 2213-4 (C), Maine. Fig. 3, pattern Q-4, 814B-7 (B), Florida. Fig. 4, pattern U-24, 1808-2, central Ohio. Fig. 5, pattern X-34, 2215-4 (B), Maine. Fig. 6, pattern AA-47, 2460-1, central Ohio. Fig. 7, pattern HH-49, 1464-1, southern Ohio. Fig. 8, pattern OO-37, 457-1, central Ohio. Numbers following the pattern represent the recording, and the song in the recording, from which the graph was made; letters in parentheses represent the series in the recording.

Plate 2. Audiospectrographs of Introductory Patterns in Towhee Songs. Fig. 9, pattern B, 2476-1 (A), central Ohio. Fig. 10, pattern C, 2215-8 (D), Maine. Fig. 11, pattern D, 2499-1, central Ohio. Fig. 12, pattern F, 1284-1 (A), central Ohio. Fig. 13, pattern G, 1127-2, southern Ohio. Fig. 14, pattern H, 2486-1, central Ohio. Fig. 15, pattern I, 2587-21 (C), central Ohio. Fig. 16, pattern J, 2390-1, Florida. Fig. 17, pattern K, 2782-1, Michigan. Fig.

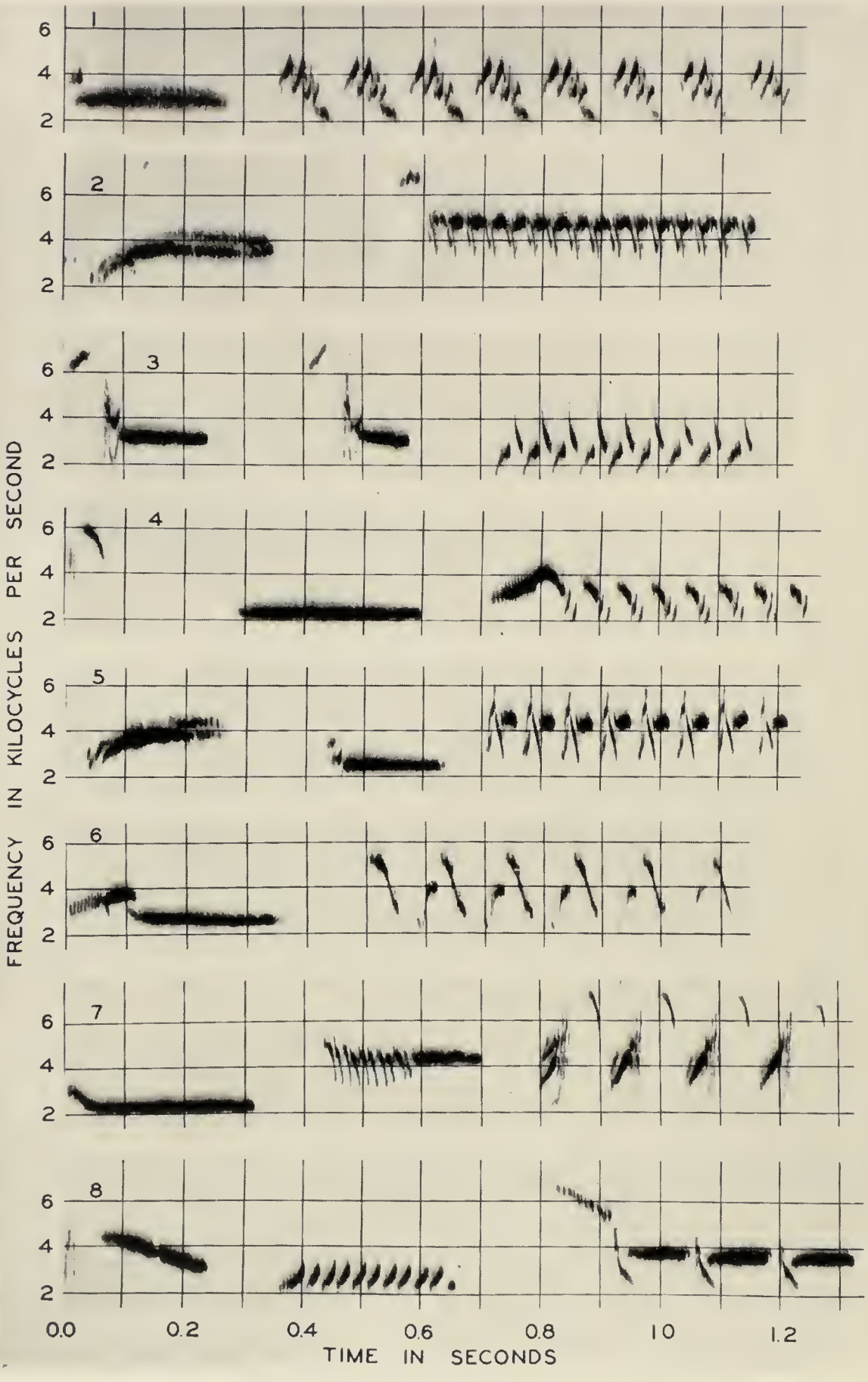
18, pattern L, 1471-1 (A), southern Ohio. Fig. 19, pattern M, 879B-6 (F), Florida. Fig. 20, pattern N, 879B-5 (E), Florida. Fig. 21, pattern P, 2476-2 (B), central Ohio. Fig. 22, pattern R, 3002-2 (A), Maine. Fig. 23, pattern S, 2706-2, West Virginia. Fig. 24, pattern T, 1786-2 (B), central Ohio. Fig. 25, pattern U, 1299-1 (A), central Ohio. Fig. 26, pattern U, 1284-4 (B), central Ohio. Fig. 27, pattern V, 2770-1, Michigan. Fig. 28, pattern V, 2489-1, central Ohio. Fig. 29, pattern V, 2578-4, central Ohio. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 3. Audiospectrographs of Introductory Patterns in Towhee Songs. Fig. 30, pattern W, 2109-1, Maine. Fig. 31, pattern W, 2941-1, Maine. Fig. 32, pattern W, 3002-5 (B), Maine. Fig. 33, pattern Y, 916B-1 (B), North Carolina. Fig. 34, pattern Z, 1641B-1, Florida. Fig. 35, pattern AA, 2587-1 (A), central Ohio. Fig. 36, pattern BB, 2757-1 (B), Michigan. Fig. 37, pattern CC, 1958-2, central Ohio. Fig. 38, pattern DD, 1734-1, central Ohio. Fig. 39, pattern DD, 2463-2, central Ohio. Fig. 40, pattern EE, 1826-1, central Ohio. Fig. 41, pattern FF, 342-3, Florida. Fig. 42, pattern GG, 921B-1, North Carolina. Fig. 43, pattern HH, 2497-1, central Ohio. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 4. Audiospectrographs of Introductory Patterns in Towhee Songs. Fig. 44, pattern II, 665-2, central Ohio. Fig. 45, pattern JJ, 1731-4 (B), central Ohio. Fig. 46, pattern KK, 879B-27 (G), Florida. Fig. 47, pattern LL, 1649-2 (A), central Ohio. Fig. 48, pattern MM, 1262-1, central Ohio. Fig. 49, pattern NN, 384-4 (B), central Ohio. Fig. 50, pattern OO, 432-2, central Ohio. Fig. 51, pattern PP, 912B-4, North Carolina. Fig. 52, pattern QQ, 2207-2 (B), Maine. Fig. 53, pattern RR, 2666-1, central Ohio. Fig. 54, pattern TT, 2207-1 (A), Maine. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 5. Audiospectrographs of Trill Patterns in Towhee Songs (only the first part of each trill is shown; the remaining phrases in each case are like the ones shown). Fig. 55, pattern 2, 1471-4 (B), southern Ohio. Fig. 56, pattern 3, 1641B-1, Florida. Fig. 57, pattern 5, 921B-2, North Carolina. Fig. 58, pattern 5, 2463-2, central Ohio. Fig. 59, pattern 6, 879B-6 (F), Florida. Fig. 60, pattern 7, 2205-1, Maine. Fig. 61, pattern 8, 1299-7 (B), central Ohio. Fig. 62, pattern 9, 2715-2 (A), West Virginia. Fig. 63, pattern 10, 2945-5, Maine. Fig. 64, pattern 11, 2213-2 (B), Maine. Fig. 65, pattern 12, 1471-4 (B), southern Ohio. Fig. 66, pattern 13, 2757-1 (B), Michigan. Fig. 67, pattern 14, 1826-1, central Ohio. Fig. 68, pattern 15, 912B-4, North Carolina. Fig. 69, pattern 16, 2207-1 (A), Maine. Fig. 70, pattern 17, 2715-3 (B), West Virginia. Fig. 71, pattern 18, 2486-1, central Ohio. Fig. 72, pattern 19, 2578-4, central Ohio. Fig. 73, pattern 20, 2215-1 (A), Maine. Fig. 74, pattern 21, 1284-1 (A), central Ohio. Fig. 75, pattern 22, 1971-2 (B), southern Ohio. Fig. 76, pattern 23, 1262-1, central Ohio. Fig. 77, pattern 24, 1649-2 (A), central Ohio. Fig. 78, pattern 25, 2520-2, central Ohio. Fig. 79, pattern 26, 1550B-1, Maine. Fig. 80, pattern 27, 879B-1 (A), Florida. Fig. 81, pattern 28, 916B-1 (B), North Carolina. Fig. 82, pattern 29, 1649-7 (B), central Ohio. Fig. 83, pattern 31, 342-3, Florida. Fig. 84, pattern 32, 1299-1 (A), central Ohio. Fig. 85, pattern 33, 2706-1, West Virginia. Fig. 86, pattern 34, 1557B-1 (A), Maine. Fig. 87, pattern 34, 3002-2 (A), Maine. Fig. 88, pattern 35, 1958-2, central Ohio. The recording, song, and series from which each graph was made are indicated as in Plate 1.

Plate 6. Audiospectrographs of Trill Patterns in Towhee Songs (only the first part of each trill is shown; the remaining phrases in each case are like the ones shown). Fig. 89, pattern 35, 2666-1, central Ohio. Fig. 90, pattern 36, 1734-1, central Ohio. Fig. 91, pattern 38, 786R-5, central Ohio. Fig. 92, pattern 39, 762-3 (A), central Ohio. Fig. 93, pattern 40, 3002-5 (B), Maine. Fig. 94, pattern 41, 2390-1, Florida. Fig. 95, pattern 42, 2499-1, central Ohio. Fig. 96, pattern 43, 1557B-6 (B), Maine. Fig. 97, pattern 44, 665-2, central Ohio. Fig. 98, pattern 45, 2781-1, Michigan. Fig. 99, pattern 46, 432-2, central Ohio. Fig. 100, pattern 46, 2587-8 (B), central Ohio. Fig. 101, pattern 47, 762-6 (B), central Ohio. Fig. 102, pattern 47, 1786-2 (B), central Ohio. Fig. 103, pattern 47, 2587-1 (A), central Ohio. Fig. 104, pattern 47, 2488-1, central Ohio. Fig. 105, pattern 47, 1728-1 (B), central Ohio. Fig. 106, pattern 48, 2587-21 (C), central Ohio. Fig. 107, pattern 49, 1296-1, central Ohio. Fig. 108, pattern 49, 2459-7 (B), central Ohio. Fig. 109, pattern 50, 2941-1, Maine. Fig. 110, pattern 50, 2445-1, central Ohio. Fig. 111, pattern 50, 2457-1, central Ohio. Fig. 112, pattern 50, 2497-1, central Ohio. Fig. 113, pattern 51, 2476-2 (B), central Ohio. Fig. 114, pattern 52, 2770-1, Michigan. Fig. 115, pattern 53, 2489-1, central Ohio. Fig. 116, pattern 54, 2782-1, Michigan. The recording, song, and series from which each graph was made are indicated as in Plate 1.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FREQUENCY IN KILOCYCLES PER SECOND
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TIME IN SECONDS

PLATE 1.

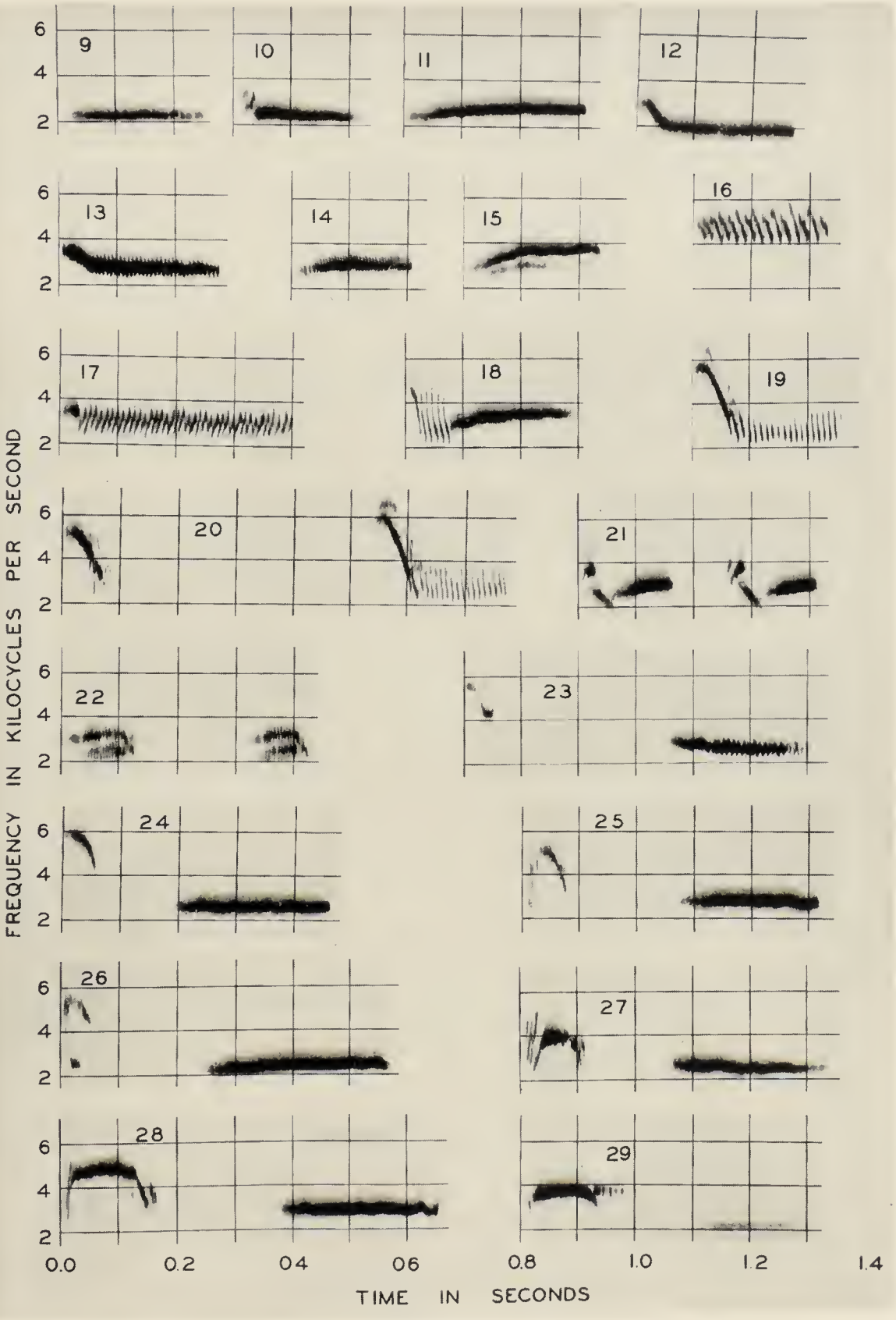
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PLATE 2.

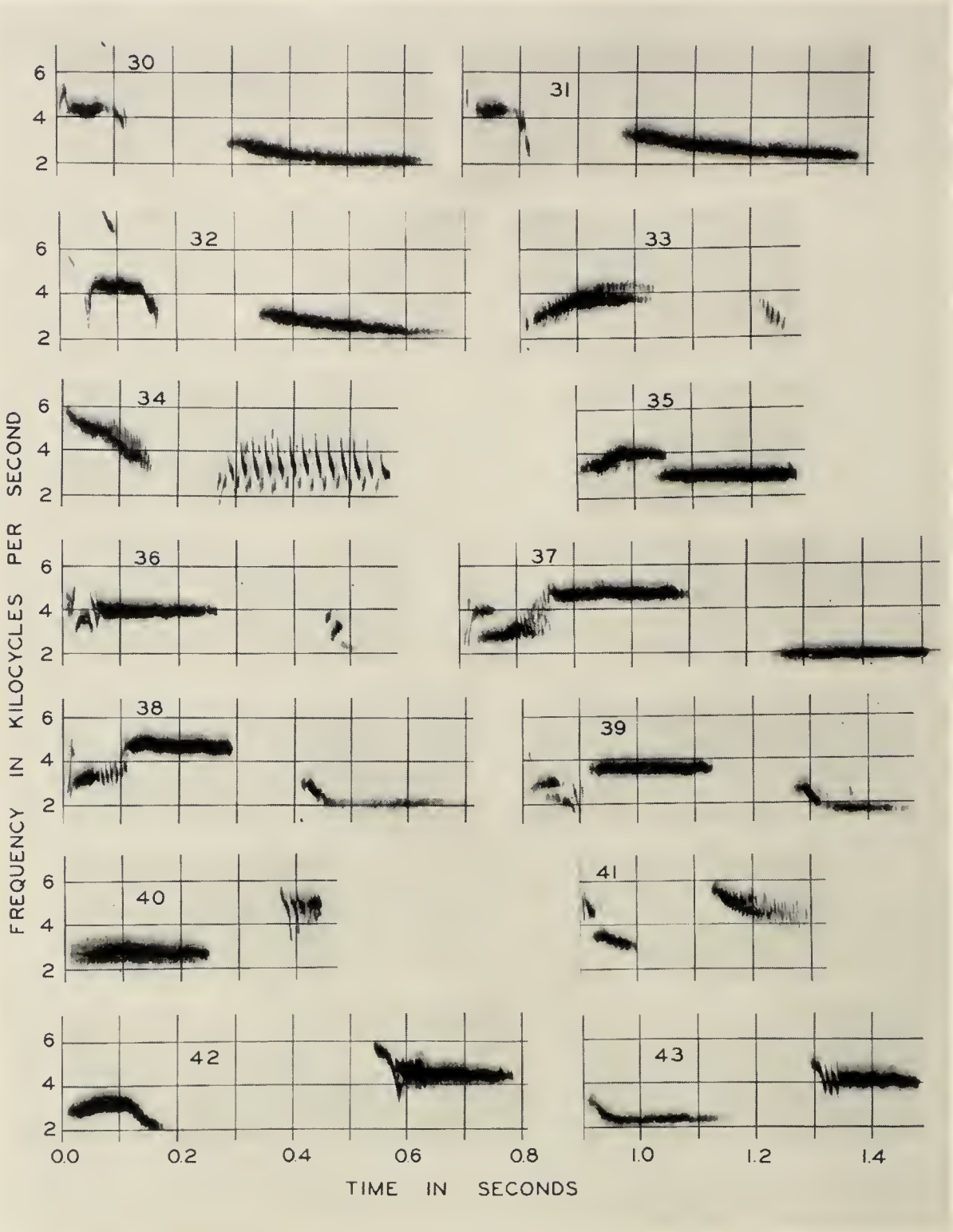
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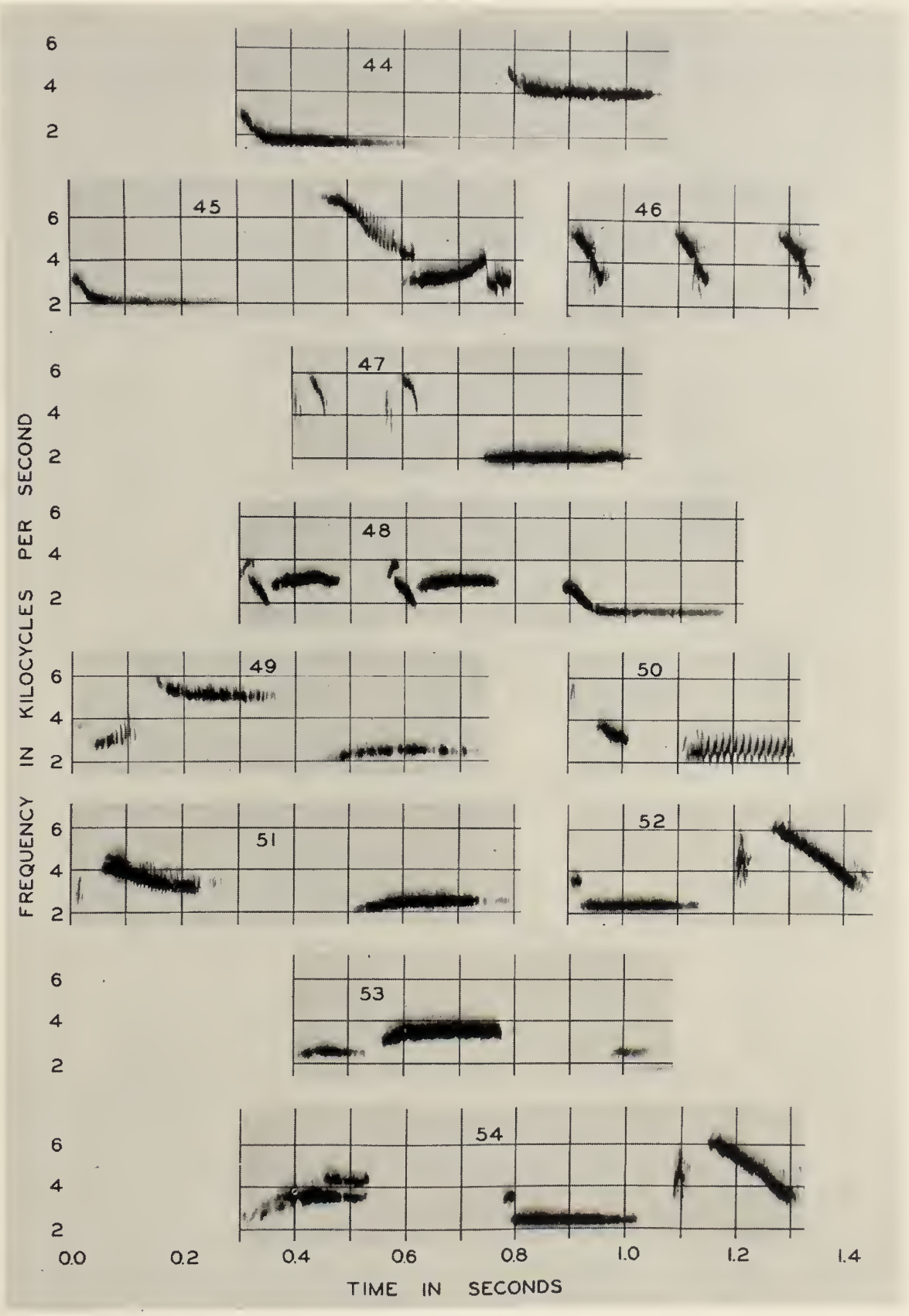
PLATE 3.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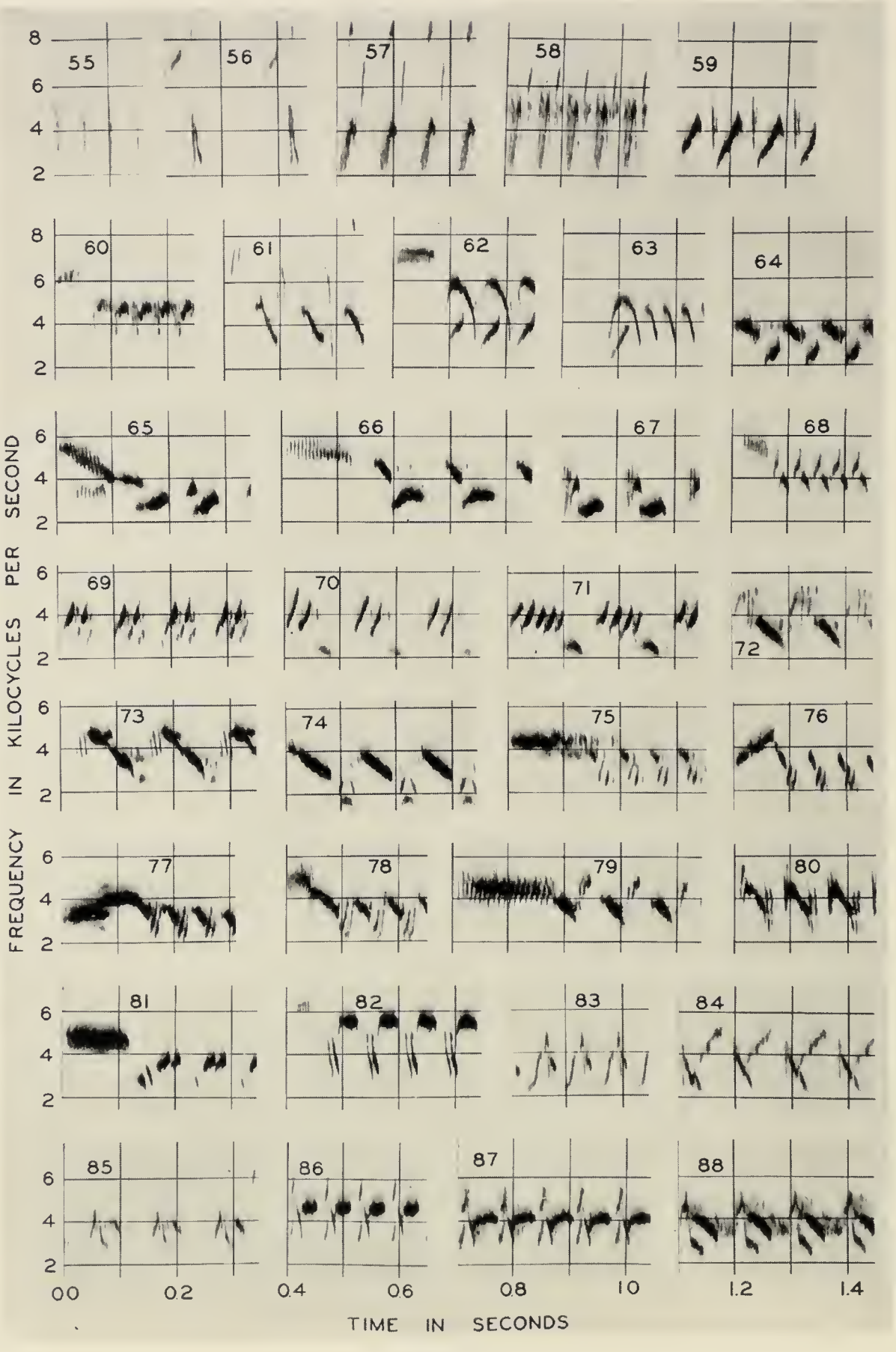
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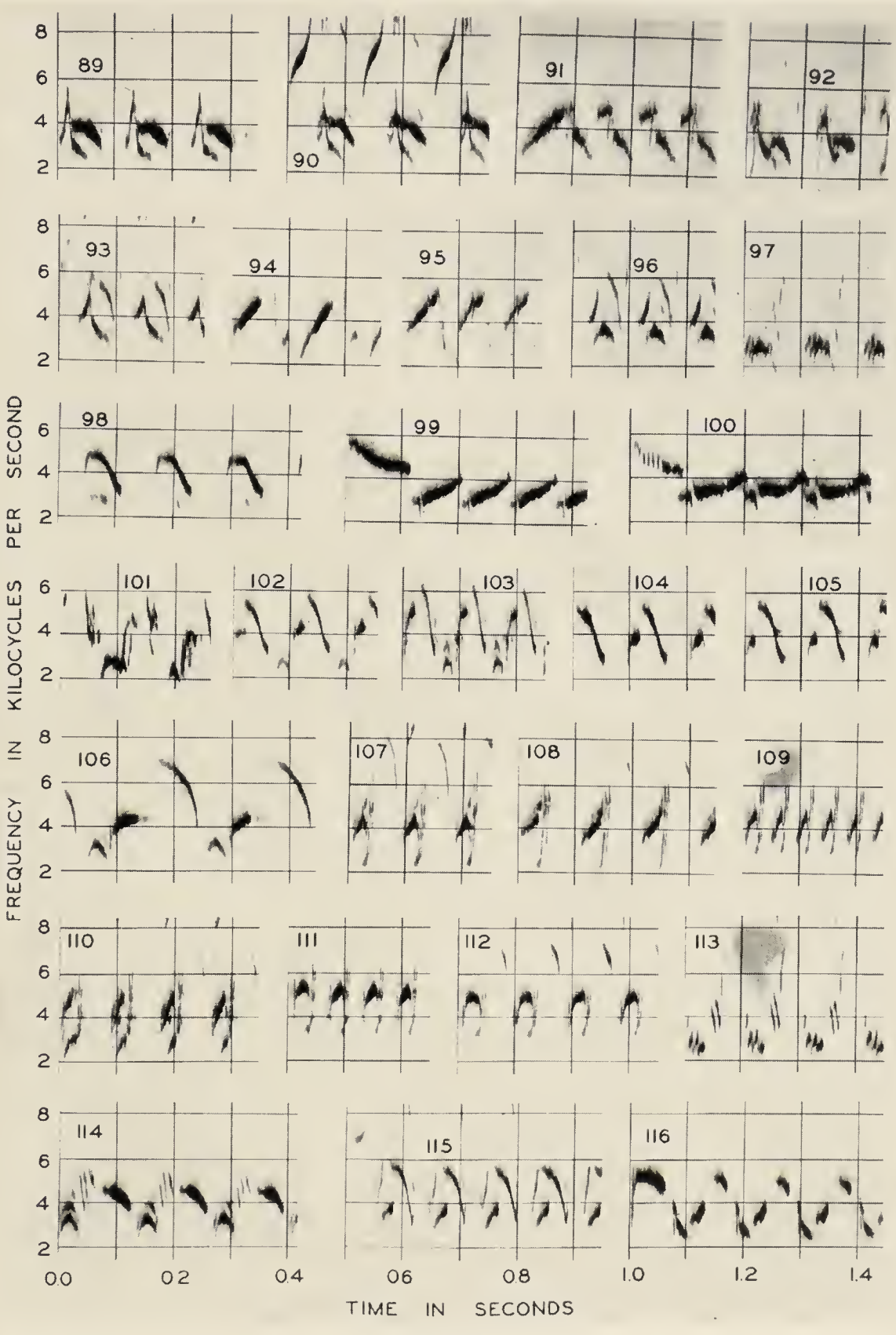
PLATE 5.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TIME IN SECONDS

PLATE 6.

Literature Cited

Borror, D. J. and C. R. Reese
1953 The analysis of bird songs by means of a Vibralyzer. *Wilson Bull.*, 65:271–276.
Saunders, A. A.
1951 A guide to bird songs (2nd ed.). Garden City: Doubleday and Co., Inc. xiv + 307 pp.

Department of zoology and entomology, ohio state university, columbus 10, ohio, december 26, 1957

OBSERVATIONS ON TERRITORIAL BEHAVIOR OF LEAST FLYCATCHERS

BY DAVID E. DAVIS

ALTHOUGH the theory of territorialism has been amply studied and reviewed, a number of aspects remain to be clarified. This study of the Least Flycatcher (*Empidonax minimus*) attempts to use information obtained about the breeding sequence to understand certain aspects of the development of territorial behavior. The paper also discusses in some detail the clutch size, hatching and fledging success, and the incubation and feeding behavior for a dozen nests.

In particular, this study has emphasized the analysis of the role of the *chebec* call of the male. Although this call is generally accepted (MacQueen, 1950) as the "territorial song," the existence of an elaborate flight-song performance in the genus (see McCabe, 1951, for detailed description for Traill's Flycatcher [*E. traillii*]) presents problems in interpretation. For Hammond's Flycatcher (*E. hammondii*) Davis (1954) suggested that the *chebec* note be called a patrol note and that it "serves to indicate to the female the position of the male." The present study pursues this problem.

The genus (*Empidonax*) has attracted attention from a number of persons. Bent (1942:174–260) assembled miscellaneous notes on the various species. McCabe (1951) observed the flight song of Traill's (Alder) Flycatcher and found that the birds simultaneously performed in the evening an elaborate song which was timed in relation to sunset, and persisted till August 8. MacQueen (1950) described the territories and song of the Least Flycatcher at the University of Michigan Biological Station for three summers. The details of her work will be discussed under each section below. Davis (1954) described the breeding of Hammond's Flycatcher at the Montana State University Biological Station at Flathead Lake for three summers and compared several aspects of six species in the genus.

The current report presents the results of observations at the University of Virginia Biological Station at Mountain Lake, Virginia, from June 13 to July 18, 1956. Unfortunately, the birds had already started nesting and thus the inception of breeding was missed. The procedures were essentially to map territories, record behavior in building the nests, determine frequency of attentive and feeding behavior, and count the number of *chebec* calls. Observations were started at dawn every day from June 14 to July 16. The individual birds were not marked by bands or other devices because it was felt that the birds might desert the nest or area, and because such marks would be very difficult to see in any case.

The problem of obtaining statistically adequate data for Least Flycatchers

arises, as it did for Hammond's Flycatcher. Although about 125 hours of actual observation time were accumulated, when divided among 10 pairs, several periods of the day, and various phases of the nesting cycle, there are only a few observations in each category and thus no useful measure of variability is available for statistical comparison of categories. Thus statistical significance cannot be determined. The result is a description of what was recorded rather than attempts at generalizations concerning the breeding of Least Flycatchers as a species. While the study is therefore deficient in this important aspect, it is considered worthwhile to report the observations because it seems unlikely that a sample of suitable size (perhaps 6000 hours!) will soon be obtained, and also because these observations may suggest generalizations.

The Biological Station is located near Mountain Lake, Virginia, about 50 miles west of Roanoke. It is on Salt Pond Mountain at an altitude of 3800 feet. The forest is basically oak–chestnut (Braun, 1950:232), although the chestnuts have been killed by blight. In addition to white oak (*Quercus alba*), which may comprise 50 per cent of the trees, red oak (*Quercus borealis*), cucumber tree (*Magnolia acuminata*), pitch pine (*Pinus rigida*), and sweet birch (*Betula lenta*) are the most important species. The grounds of the Biological Station have been cleared and present a park-like appearance (Fig. 1). The flycatchers inhabited this area as well as more dense adjacent areas. Large tracts of apparently suitable dense vegetation lacked flycatchers. Perhaps the Least Flycatchers that lived in the dense vegetation can be considered as overflow from the open area (Fig. 1), and thus do not contradict Breckenridge's report (1956) that these flycatchers are scarce in dense vegetation.

The birds formed a definite colony in the study area. Searches in nearby areas revealed no birds, even in apparently suitable vegetation. Actually there were two parts to the colony. The area of the Station grounds (Part 1) consisted of about 19 acres, and contained nine nests and two pairs that failed to nest. The flycatcher density thus was 22/19, or 1.2 birds per acre. The other area (Part 2) adjoined the Station on the south and bordered the road to Mountain Lake. It consisted of about 9.5 acres. Observations in this area were not as intensive. During the time available only one nest and one fledged brood were found although two other pairs may have been present. On this basis the density was 8/9.5, or 0.8 bird per acre.

Colonial distribution has been recorded by a number of observers (Bent, 1942; Kendeigh, 1947:48; MacQueen, 1950). The latter recorded densities of 2.0 to 2.7 pairs per acre, which is much higher than the density here recorded.

The other birds present included (in decreasing order of abundance) Robins

(*Turdus migratorius*), which built at least 15 nests on the grounds; Cedar Waxwings (*Bombycilla cedrorum*), which nested commonly; Rufous-sided Towhees (*Pipilo erythrophthalmus*); Eastern Wood Pewees (*Contopus virens*); Yellow-shafted Flickers (*Colaptes auratus*); Rose-breasted Grosbeaks (*Pheucticus ludovicianus*); Eastern Phoebes (*Sayornis phoebe*); and Chestnut-sided Warblers (*Dendroica pensylvanica*) on the borders.

A preliminary remark about identification of sex is necessary. Since the plumage is identical, sex was determined by the *chebec* call. The claim that only the male makes this call is based on the fact that both birds of a pair never gave the *chebec*; the bird that built the nest and incubated never gave it. Although no birds were collected here, collections of Hammond's Flycatcher (Davis, 1954) always verified the belief that only the male called.

Fig. 1. The nesting area of Least Flycatchers, showing the park-like habitat.

Vocalizations

The Least Flycatcher has a variety of notes that serve various functions. The notes and their presumed function will be described below and then the suggestions of other authors will be discussed.

Male Position Note.—This is the familiar *chebec* note, which is generally

considered to be the territorial song. The note is sharp and harsh and the first syllable is about five scale tones above the second. The frequency during the day and during the nesting cycle is given in Table 1. The data are grouped into time periods that are somewhat arbitrary, but are based on obvious changes in frequency and on the number of observations available. The stages of breeding are divided into two intervals for laying (assuming that 4 eggs were laid) and three five-day intervals for incubation and feeding. The day incubation began is called zero. It is, of course, obvious that such arbitrary divisions are somewhat unsatisfactory in the examination of continuous trends, but some decision was necessary for analysis. Table 1 gives simply the total minutes of observation for each category and the rate of calling *chebec* per 15 minutes. Thus in the first cell (0430–0530 for stage –4–3 days), during 97 minutes of observation, the birds gave *chebec* calls at an average rate of 359 per 15 minutes. The value was obtained by averaging the rate for each bird rather than dividing the total calls given by all birds by the total minutes of observations. For example, the first cell (0430–0530 for –4–3 days) comes from four observations varying from 12–42 minutes long and having rates varying from 62 to 775 per 15 minutes.

The table shows that in these observations the number of *chebec*'s declined markedly during the day. Also, the number of calls from 0430–0530 declined during the breeding cycle after the first stage. The calls after 0530 showed no striking change during the cycle. The increase from days –4 and –3 to days –2 and –1 will be discussed under territory.

TABLE 1

FREQUENCY OF *CHEBEC* CALLS PER 15 MINUTES DURING DAY AND DURING NESTING CYCLE

Stage of breeding	Days	Time periods of day (EST)								Birds observed
		0430–0530		0530–1000		1000–1230		1300–2000		
		Min.	Per	Min.	Per	Min.	Per	Min.	Per	
Laying	–4–3	97	359	279	99	0	–	50	54	3
	–2–1	60	733	35	217	90	2	40	2	1
Incubating	0–4	91	595	777	160	15	281	230	73	2
	5–9	60	242	902	78	86	69	60	51	4
	10–14	116	150	864	121	0	–	107	0	3
Feeding	15–19	80	211	413	196	0	–	0	–	3
	20–24	135	118	614	100	185	12	270	4	4
	25–29	220	102	765	54	60	5	739	4	4

Min.—Total minutes of observation during this time period and stage.
Per—Average number of **chebec** calls per 15 minutes.

The decline in calls in the early morning is analyzed in more detail in Table 2. The frequencies are divided according to incubation and feeding, and a

decline between these stages is apparent in all the time periods. A slight increase of calls occurs in the very early morning and then a decline during the rest of the time. The decline is rather gradual for the group, but for any one bird may be abrupt on some days. However, no marked "rhythmic song" period was observed as reported by MacQueen (1950:201). Certainly no "end" could be assigned to the calling period except for some birds.

TABLE 2

FREQUENCY OF *CHEBEC* CALLS PER 15 MINUTES FROM 0430–0630

Stage	0430–0445		0445–0500		0500–0515		0515–0530		0530–0600		0600–0630	
	Min.	Per	Min.	Per	Min.	Per	Min.	Per	Min.	Per	Min.	Per
Incubating	25	605	62	788	100	220	85	266	367	161	299	97
Feeding	51	331	111	357	158	188	182	78	388	20	280	24

Min.—Total minutes of observation during this time period and stage.
Per—Average number of **chebec** calls per 15 minutes.

Other observations suggest that the frequency of *chebec* is less in the afternoon than in midmorning. Counts were made on Male 6 on five mornings between 0900–1000, and on seven afternoons between 1500–1600. The mean calls per hour was 13.5 for the morning and 3.36 for the afternoon.

The conclusion that the frequency was less for the feeding stage than for the incubating stage can be examined at Nest 1 where observations were made at the same times of day before and after hatching. In 24 half-hour periods before hatching the average was 100 (SD = 210), while after hatching the mean for 22 half-hour periods was 28 (SD = 47). $P < .01$. A change of this type might of course be due to a purely seasonal trend. To check this point counts on the same days of birds that are incubating and of others that are feeding are required. Such counts are available for only a few birds and are thus highly influenced by the individuality of the bird. However, the males in the incubation phase did call more frequently than the males in the feeding phase.

The male starts calling before sunrise. The starting time was obtained for one male on 10 mornings. It varied from 0424 to 0444. Sunrise during this time (June 17–July 3) was essentially at 0450 (EST). This bird appeared to start later on rainy mornings and later as the breeding cycle progressed.

There was so much individual variation among the males that some comments about each male seem justified. Male 1 was a persistent caller, who gave 52 per cent of his calls from two white oaks. He called regularly during the day after a rapid series early in the morning. He also called regularly when feeding the young and even after they had left the nest. Male 2 (nest with young when observations started) called rapidly early in the morning but only occasionally during the day. He called in early morning even when the

young had been out of the nest for 20 days. Male 3 was very quiet and called only rarely after 0500. In the feeding stage he called so rarely that the identification of sex was not possible at feeding. Male 4 called regularly and followed the average pattern until the nest was deserted, when he increased his calls to around 450 per 15 minutes. In fact, the sudden increase in calling during the entire day aroused suspicion and it was then found that the nest was deserted. The male remained for eight days but his calling decreased markedly after the fourth day. Male 5 was the most persistent caller of all the males. He called late in the day and frequently during feeding and even after the young had left the nest. Male 6 was an "average" caller. Male 7 (whose mate built and abandoned four nests) called very frequently and persistently after the first few days. His calls increased from 13 per 15 minutes on the first day of observation (female building) to 91 (female building second nest) to 927 (female building third), but declined to 560 (female building fourth). However, when the female disappeared he called at 960 per 15 minutes for several mornings and also very frequently during the day. He was last heard seven days after the female disappeared. Males 8 and 9 were observed only in the feeding phases. Both called regularly very early (0445–0500), after the young were out of the nest, at a high frequency (300–900 per 15 minutes) for about 10–15 minutes and then practically stopped for the day. Male 10 was first noticed on June 25 when the female laid her first egg of four. He was noticed because of his calls, but the rate was very low (32 per 15 minutes). It seems certain that the frequency had been even lower in the building phase because the bird had not been noticed although considerable time was spent at the adjacent nests. The calls increased to 855 on the day the last egg was laid and continued normally during incubation. Male 11 was a very frequent caller for several days. (The female was seen only once, at her empty nest on the day it was found.) He continued for several days after she disappeared. Male 13 nested late (female laid July 2) and called at a high rate during laying but soon stopped except for a short time very early in the morning.

Female Position Note.—A soft, mellow note is given by the female when building or off the nest. Phonetically it resembles *whit*. The note is not given from the nest or when the male arrives. It appears to have the same function as the *chebec* note of the male. Apparently this note is the one rendered as *chweep* by MacQueen (1950:203) rather than the one rendered by her as *whit*. Some counts of the female position note suggested that the frequency may increase at fledging.

Alarm Call.—The alarm call is given by both male and female and sounds like *tweep*. It is rather harsh and loud but the male note is slightly lower in pitch than that of the female. The note is given sometimes when a person comes near but characteristically when a cat, Blue Jay, or black snake appears. This must be the note rendered as *whit* by MacQueen because she says both sexes give it, even though she says her *chweep* was given in defense of the nest.

Flight Song.—A performance was observed on the evenings from June 16–25 at dusk. The typical development was that several males started calling *weep* (ascending in pitch at the end) sporadically and hopping upward in a tall tree. Then after more rapidly repeated *weep* notes, several birds would fly about 100 feet above the trees uttering an assortment of warbles, *weep*'s, and *chebec*'s. Then the bird would tumble and dive into the treetop, flying more

like a butterfly than like a bird. This song is obviously the flight song reported by various authors and described in detail for Traill's (Alder) Flycatcher by McCabe (1951). The performer is assumed to be a male because all gave *chebec* calls.

The performance occurred between 1950–2010 (sunset at 1912) on each evening observed. Birds in all stages of breeding performed. Observations were made every evening from June 16 to July 5, but the last flight song was observed on June 26. It was impossible simultaneously to observe every bird, and thus some performances were missed. However, it was possible to be in a position to watch and identify several at the same time. It is clear that the birds whose females were building or laying performed most constantly. To compare the frequencies according to the phase of the cycle the number of birds performing may be compared with the chances to observe a bird (which is the number of evenings multiplied by birds in the phase). Males in the building phase performed on 4 of 9 chances; males in the laying phase performed on 5 of 6; males in the incubating phase performed on 8 of 33; and in the feeding phase on 2 of 44. On the two evenings when no actual flight was made, several birds started the performance by calling *weep, weep* and ascending in the tree, but failed to fly up.

This performance was never observed in the early morning, although observations were started daily at 0415 when there was less light than at the time of the evening performance.

Greetings.—Both the male and female may chatter and twitter when they meet away from the nest or at the nest. Typically the greeting is given when the female comes off the nest during incubation or comes from the nest during feeding of the young.

Defense.—During the latter part of the observation time a number of strange birds wandered through the area. Presumably these birds had lost their nest or mate by some accident and were searching for a new place. The owners of the territory met these birds with a series of *weep-weep* notes, identical to the notes in the flight song, and drove the strangers away. This note in clearly an aggressive note. It was not possible to determine whether the female gave the note.

Building Note.—A *churr* was given by the male and female as she built the nest. but its function is not known. It was not heard after incubation began. The birds flutter their wings somewhat as they go from branch to branch.

Calls of Young.—During the last few days of feeding the young may produce some notes in the nest. However, as soon as the young leave the nest they emit a mellow chip note that apparently serves as a location note to help the adults find them. In one case a young bird gave this call when it was out on a branch near the nest but not after it hopped back into it.

Territorial Behavior

The territorial behavior of the Least Flycatcher very closely resembles the behavior of Hammond's Flycatcher (Davis, 1954) and other members of the genus: Dusky (*E. oberholseri*), Acadian (*E. virescens*), and Western (*E. difficilis*) (personal observations). The males defend the territory and the females defend a small area around the nest. After the young leave the nest both male and female drive other Least Flycatchers away from the territory even though the young may be outside.

The young generally leave the territory. Two broods left one day after hatching, three broods left two days after (but one of them returned to its territory 13 days later), one brood remained in its territory for 12 days, while another remained 13 days.

The size of the territory differs among pairs and according to the stage of breeding. Although it is difficult to define the boundaries precisely, in general the male has a territory ranging from 0.35 to 0.55 acre in size. The territories of four males in incubation or laying were 0.33, 0.35, 0.54 and 0.55 acre. Territories of three males during the feeding phase were 0.15, 0.26 and 0.37 acre. One male had a very large territory (2.8 acres), which was reduced to about 0.3 acre during feeding. It is perhaps significant that this bird had a neighbor on only one side of his territory. Another bird, which started nesting late (June 26), had a territory of 0.23 acre bounded on nearly 80 per cent of the periphery by other birds. The female may use part of the male's territory or have an area of her own to which the brood may go when leaving the nest.

The defense of the territory is performed by active fighting. The male defends a larger area than does the female. The function of the various notes in the defense of the territory is not clear. Presumably the flight song is territorial, although it is not performed during the daytime. An integral part of the flight song is the defense note described above as *weep-weep*. It was performed regularly by the male when driving out an intruder and actually fighting. On 24 occasions a fight between flycatchers was observed, and on 18 the defender used the call. In two other cases an invader used this call. On seven occasions *chebec*'s accompanied the fights but at no greater rate than usual. Twice after severe fights no *chebec*'s were given. The *weep* note was given at all stages of breeding, but was more common later, presumably because more strangers were around. While the above evidence suggests that the *weep* call is a means of territorial defense, some other evidence does not support this conclusion. On June 25 a pair took up a territory adjacent to another pair that was feeding young. Not until July 1 (second day of incubation) was the *weep-weep* call heard, although some fights between the males had been seen. However, the number of *chebec*'s was no greater than normal by either bird.

The observations cited above do not suggest that the *chebec* is a territorial song; they show that the *weep-weep* note is aggressive. However, some other observations agree with the interpretation that *chebec* is territorial. It is clearly given from a few particular perches that are conspicuous. It may be used in opposition to an adjoining male. The male stops calling *chebec* when he leaves his territory. But in contrast to this view is the fact that at both nests which were started after observations began, the *chebec* calls did not reach maximum frequency till the cycle was advanced. In one case the bird was not heard till the day the first egg was laid, even though observations were made in adjacent areas. In the other case the male did not reach the maximum until the sixth day of building (the female started four nests). When the female disappeared (two cases) the number of *chebec* calls increased from 50 to 376 per 15-minute interval. No female was obtained although several were wandering around. Neither of these behavior sequences fits the pattern of conventional territorial song behavior.

When fighting against other Least Flycatchers or other species the bird clicks its bill rapidly thus making a loud clatter. The Least Flycatcher was seen to drive Robins, vireos, White-breasted Nuthatches, Cedar Waxwings, Rufous-sided Towhees, warblers and Wood Pewees away from the nest and young. Yellow-shafted Flickers and Hairy Woodpeckers were watched but not attacked.

The patterns of fighting described above do not fit the "typical" (Song Sparrow, Indigo Bunting) territorial behavior. In particular the two types of song are peculiar. The current observations agree with the suggestion (Davis, 1954) that the notes (the *chebec* of the Least Flycatcher and Hammond's, and the corresponding notes of other species) serve to indicate to the female the position of the male. Similarly the female note (here called *whit*) indicates to the male the position of the female. The vigorous calling in early morning is not clearly explicable on this basis, but might be an extension of location notes needed in the darkness. It has long been accepted that the function of territorial song is to repel aggression and to advertise to the female that a male is present. Perhaps in these flycatchers these functions are each attached to different notes so that there exists aggressive song and advertising song (position note).

Nesting Cycle

Nest.—The nest is built in a crotch of a small tree or fork of a large tree, or on a lateral limb. Of 14 nests observed, 4 were in a crotch of a white oak sapling (about four inches DBH) and 7 were on a horizontal branch of a large white oak, 2 were on branches of pitch pines and one was on a branch of a sugar maple sapling. The average height was 15.8 feet, distributed as follows: 7 feet, 1 nest; 11–12 feet, 4 nests; 13–14 feet, 4 nests; 15 feet, 2 nests; 27 feet, 1 nest; and 35 feet, 1 nest. One female started four different nests on horizontal branches of large white oaks, all 20–30 feet above the ground.

The nest is a compact bowl, constructed from plant fibers and lined with some feathers or fluffy plant material. The inside diameter is two inches. The nests were very similar irrespective of location. In only one case was building observed and it may have been abnormal. A female over a period of seven days started four nests. The first was demolished by waxwings and the others were abandoned. The male did not accompany the female on her trips to the nest but called nearby.

Eggs and Young.—Five nests when first observed had eggs. The average clutch was 3.4 and was distributed thus: 2 eggs, 1 nest; 3 eggs, 1 nest; 4 eggs, 3 nests. Three other nests had young when first observed: 4 young, 2 nests; 3 young and 1 unhatched egg, 1 nest. Assuming that none of these latter 3 clutches originally had 5 eggs, the mean clutch size was 3.6. Six nests were inaccessible or destroyed before the contents were observed.

One egg in one nest did not hatch and none of four eggs in a late nest hatched. Thus the proportion hatching was 24/29 = 83 per cent. This result does not include a nest that was empty when found and was deserted the following day by the female.

Only one young failed to fledge. Thus the proportion was 23/24 = 96 per cent for the seven nests for which data were obtained. The proportion of eggs that produced fledglings was 83/96 = 80 per cent.

The duration of nestling period was obtained in four cases: one of 14 days, two of 15, and one of 16. The period was measured from the day the first young hatched to the day that one of the young left the nest. The time of departure was observed at seven nests. In five cases the young left before 1000. In one case the two young left about 1900, and in one case three left about 1900 and one left the following morning.

Independence may not be attained for about three weeks. One brood was still fed by the adults at 21 days although the young had been catching insects by themselves for five days. All the other broods left the area before the stage of independence was reached. No young were known to have died in the post-fledging period of dependency.

Incubation.—The incubation is performed by the female alone. This agrees with MacQueen (1950:198) but is contrary to Bent's opinion (1942:216) that "probably both sexes incubate." Quantitative data on incubation and brooding are presented in Table 3. The percentage of time on the nest is remarkably constant during the day and during the stages. The only outstanding value is for early morning 0–4-day stage, but this is merely sampling variability, for most of the data were obtained on one bird on the morning of the day incubation started. The average of the percentages in Table 3 (omitting 28.4 per cent) is 77.1 per cent which can be used as the percentage of time the female is on the nest.

TABLE 3

PERCENTAGE OF TIME SPENT INCUBATING OR BROODING

Stage	Days	Time of day					
		0430–0730		0830–1230		1330–2000	
		Min.	Per Cent	Min.	Per Cent	Min.	Per Cent
Incubation	0–4	244	28.4	207	75.5	236	81.5
	5–9	388	80.0	323	76.3	0	—
	10–14	884	82.0	397	73.2	529	78.2
Brooding	15–19	456	77.3	357	74.5	387	72.9

Min.—Total minutes of observation during this time period and stage.

The duration of incubation was not obtained for any clutch, but is assumed to be 14 days, although Bent (1942:216) states "the period of incubation is said to be 12 days." The assumption of 14 days is based on the meager evidence that incubation lasted at least 12 days in one nest and that Davis (1954) found a period of 15 days for one nest of Hammond's Flycatcher.

The male may feed the female while she incubates. At one nest he fed her 11 times in 360 minutes and at another nest 12 times in 128 minutes. The weather was cold and foggy on these days.

The eggs in most nests hatched over a period of two days but in one nest during three days. The female continues to brood for several days. She stays on the nest at night at first but when the young become large, she perches on the edge.

Feeding.—The male and female feed the young. During the early stages of feeding the male sometimes gave food to the brooding female who then gave it to the young. The sex of the bird could usually be determined by a difference in behavior, checked by the call notes. The male characteristically perched on a small twig to feed the young, whereas the female perched on the nest or in some cases on a different branch. The individual birds were very consistent in their approach. In one case the male changed perches in the last three days apparently because the size of the young made the former perch unsuitable. Some males called *chebec* regularly at feeding. Male 1 called 25 times for 99 feedings.

Table 4 gives the frequencies of feeding. The data are divided into stages of nestling development by 5-day periods and into three parts of the day. It is apparent that the total rate of feeding increases rapidly and more than doubles from early to late nestling stage.

TABLE 4

HOURLY FEEDING RATES BY TIME OF DAY

Stage of nesting	Time of day					
	0430–0730		0830–1230		1330–2000	
	Min.	Rate	Min.	Rate	Min.	Rate
15–19 days	315	4.8	411	7.5	743	4.8
20–24 days	570	14.0	622	10.6	1029	11.7
25–29 days	727	16.2	701	13.6	1039	14.6

Min.—Total minutes of observation during this time period and stage.

The number of young also affects the feeding rate. One nest had two nestlings and the other nests all had four nestlings. The average rate per hour was 7.2 in the nest with two young, and 14.2 in the other nests. These figures include all observations and the distribution by time of day and stage of feeding is comparable.

Table 5 gives the percentages of feedings by the male. The sex was identified in 65.6 per cent of 1280 feedings. No trend in proportion of feedings by the male is apparent either by stage of nesting or time of day.

The fecal sac was removed by males and females. Within a pair, however, considerable difference in frequency appeared to occur.

When the young are 12–13 days old they begin to flap and stretch their wings. In another day they may stand on the rim of the nest and flap their wings very rapidly. On about the 15–16th day they may leave the nest. A bird may hop out to a branch and then come back in. When they leave, they can fly a yard or more. They generally hop gradu-

Table 5

Percentage of Feedings by Male

Stage of nesting	Time of day					
	0430–0730		0830–1230		1330–2000	
	Feedings	Per Cent	Feedings	Per Cent	Feedings	Per Cent
15–19 days	22	40.8	50	68.0	38	42.1
20–24 days	91	66.8	55	52.7	110	55.5
25–29 days	164	59.8	199	39.2	111	47.7
Totals	277		304		259	
Means of percentages		55.8		53.3		47.1

ally upwards till they are about 30 feet up. The young may sit together on a branch to be fed and to sleep.

Duration of Breeding Season.—The date of laying for 12 nests can be approximated by calculation backwards from known dates of hatching or fledging. Assuming 14 days for incubation and 15 for fledging, the laying dates are: May 24 (2 nests), May 31, June 4, 5, 7, 10, 11, 12, 18, 28, and July 2. It is apparent that in 1956 in this area the peak of laying occurred in the first week of June. Presumably the late nests were renesting by birds whose first nest or mate had been destroyed.

There was no evidence of a second nesting in this area. No breeding behavior was seen in the territories where a brood had been successfully raised. Furthermore, both male and female care for the young for as much as 20 days after leaving the nest. However, Bent (1940:216) states (without evidence) that two broods are "often, if not regularly" raised in the southern portion of the range.

I wish to acknowledge the collection of data by the following students: Edward Daley, Pauline Lorvan, W. J. Pitman, Robert Price, and Alice Walrath. Only observations that were mutually agreed to be reliable were included.

Summary

During the summer of 1956, observations of territorial behavior and nesting of the Least Flycatcher (*Empidonax minimus*) were obtained at the University of Virginia Biological Station at Mountain Lake, Virginia. The birds nested in the oak forest and the park-like grounds of the Station. Most of the 14 nests were in oaks, either in a crotch or on a branch. The average height was 16 feet. The clutch size was 3.6 based on five nests with eggs and three nests with young when found. About 80 per cent of the eggs produced fledglings.

The call notes consist of at least eight types. (1) The male position note (*chebec*) is given at a rate of about 700 per 15 minutes, from 0430–0530 at the time of laying. It declines during the day and the rest of the breeding cycle. It increases in frequency during laying and after disappearance of the female. (2) The female has a note (*whit*) that appears to have the same function. (3) The alarm (*tweep*) is given by both sexes. (4) The flight song at dusk is performed by the male. (5) Greetings are given when members of

a pair meet. (6) An aggressive call (*weep-weep*) is used when fighting with other Least Flycatchers. (7) A special note (*churr*) is given as the nest is built. (8) The young have a location note.

Incubation is performed only by the female, who spends about 80 per cent of her time on the nest. Males and females feed the young about equally frequently. The rate of feeding by both birds increased from about six per hour during the first third of the feeding phase to about 15 per hour during the last third.

The territorial behavior resembles that of other members of the genus. The males defend an area but the role of the *chebec* note is not clear. It is given from prominent places within the territory but it is not used when fighting and, in the two cases available, increased in frequency up to the start of incubation. Defense of territory is associated with an aggressive note.

Literature Cited

Bent, A. C.
1942 Life histories of North American flycatchers, larks, swallows, and their allies. *U. S. Natl. Mus. Bull.*, 179:1–538.

Braun, E. L.
1950 Deciduous forests of Eastern North America. Blakiston Co.. Philadelphia. 596 pp.

Breckenridge, W. J.
1956 Measurements of the habitat niche of the Least Flycatcher. *Wilson Bull.*, 68: 47–51.

Davis, D. E.
1954 The breeding biology of Hammond's Flycatcher. *Auk*, 71:164–171.

Kendeigh, S. C.
1947 Bird population studies in the coniferous forest biome during a spruce budworm outbreak. *Dept. Lands and Forests, Ontario Biol. Bull.*, 1:1–100.

MacQueen, P. M.
1950 Territory and song in the Least Flycatcher. *Wilson Bull.*, 62:194–205.

McCabe, R. A.
1951 The song and song-flight of the Alder Flycatcher. *Wilson Bull.*, 63:89–98.

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NOTES ON THE NESTING OF SELECTED SPECIES OF BIRDS OF THE SONORAN DESERT

BY M. MAX HENSLEY

These miscellaneous data were collected during June and July of 1948, and from February through August of 1949, in a study (Hensley, 1954) of the breeding birds of the intermountain desert plains in Organ Pipe Cactus National Monument, Arizona. Notwithstanding the time interval since the conclusion of that study, it seems likely that the data presented here may be of interest to investigators concerned with the bird species found in this significant region. The topography, flora, and breeding bird population are given in detail in my earlier report (*ibid.*).

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Systematic List

Of the 25 representatives of 16 families of birds known to nest in the region, observations on 16 species are presented below.

Turkey Vulture (*Cathartes aura*).—This species was recorded from March 1 through August. One nest with two eggs was discovered on May 31 in a cairn of rocks in a small valley. The boulders were arranged so as to form a chamber, 10 feet in diameter and about 3.5 feet high, with a single small entrance.

Red-tailed Hawk (*Buteo jamaicensis*).—Eight nests of this resident species were located in saguaros (*Cereus giganteus*), but only one site was suitable for frequent observations. This nest contained two eggs when found on April 1. Both adults shared in the incubation of the eggs and care of the young. The first egg hatched on April 7. On May 19, 42 days later, the young birds were still in the nest but left within the next two or three days.

The food of these hawks consisted mostly of rodents with the round-tailed ground squirrel (*Citellus tereticaudus*) the most common species taken. The desert spiny lizard (*Sceloporus magister*) and Clark's spiny lizard (*S. clarki*) were both found in this nest. One of the adults was seen flying overhead with a sizable snake dangling from its talons. The heads of the rodents were generally removed before being offered to the young, while the lizards were entire. The most active feeding periods appeared to be during the mid-morning (8 to 9 a.m.) and again around 5:00 p.m.

Harris' Hawk (*Parabuteo unicinctus*).—Two nests of this resident hawk were found in saguaros. Some 10 hours of observations were made at a nest which contained two eggs on April 17. It was placed about 19 feet above ground in a cradle made by two short arms of the cactus.

Both sexes are said to share in incubation (Bent, 1937) but I recorded only the female incubating at this nest on each of three visits. Both eggs hatched on May 4, 17 days after the nest was found. Two days after hatching one nestling was found dead at the base of the saguaro. The down at this stage was a soft "pinkish buff" color above, fading to white below. On the eighth day the surviving chick had lost the early reddish-colored natal down and appeared completely white. The wing and tail feathers were fully developed within two weeks and at approximately 17 or 18 days the crown, back, and scapulars were covered with juvenal feathers. The first wing exercising was noticed at this age and food was being left at the nest for the young to pick up unaided. It was not until May 31, when the young bird was 27 days old, that it was seen actively feeding from a carcass left at the nest.

Feeding was observed on the fourth and eighth day after hatching. On both occasions the adult tore the food into small pieces which were rapidly picked from her bill by the nestling. Food was brought to the nest two or three times daily, in the early morning, midafternoon, and late evening as a rule. Round-tailed ground squirrels were the only animals recorded being fed and invariably the heads of the rodents were removed prior to feeding. The intestines and skin of the ground squirrels were not fed to the young nestling, but were consumed by the adults at the nest. On three occasions branches of the mistletoe (*Phoradendron californicum*) were brought to the nest by the adult birds. In the first instance the fledgling picked at the twigs. On the other two occasions the twigs were ignored. So far as is known, vegetative items do not comprise any part of the diet.

The young bird left the nest at about five and one-half weeks of age but remained in the vicinity for several more days.

Gambel's Quail (*Lophortyx gambelii*).—Twelve pairs of Gambel's Quail were found nesting in wash areas where adequate cover was available. Nesting of this permanent resident was under way by the latter part of March. The first brood was observed on May 12, when 15 to 20 young chicks were counted with the attending adults. Six pairs were seen with broods ranging from three to 20 chicks each.

White-winged Dove (*Zenaida asiatica*).—White-wings may be seen almost anywhere during the summer season. The fruit of the saguaro was found to be the most highly favored food and was consumed throughout the ripening period. Also, the fruit of the condalias or wild jujubes (*Condalia lycioides* and *C. spathulata*) was consumed.

My first White-winged Dove record was April 19, after which the population gradually built up to a peak in May. The first nests were found on June 2, and each contained two freshly laid eggs. The latest date of active nests was July 27, when one nest had two very young nestlings and another contained two eggs. These July records indicate second nestings as they were well toward the end of the breeding season for all species. Only two other nests were still active at this date: a Curve-billed Thrasher with two eggs under incubation and a pair of Gila Woodpeckers with young about ready to fledge. The height of the nesting season for the doves was during the first part of June. Neff (1940) recorded one nest with eggs on August 5.

Incubation lasted 14 days (June 7 to 21, date of last egg laid to last egg hatched) in one nest and 18 days in another (June 2 to 20). In accordance with Kendeigh (1952), the attentive periods of the adults at these nests lasted for several hours during incubation. The single exchange of incubating birds observed was accomplished in a matter of seconds.

Chasing was observed on only one occasion, when a male (?) gave chase to another White-winged Dove which stopped to rest in the nest tree. Of the 26 pairs observed nesting this was the only instance where this behavior was noted.

Nest locations varied in height above the ground from 3 to 25 feet with an average of 7.5 feet. Thirteen were placed in palo verde (*Cercidium microphyllum* and *C. torreyanum*) (av. 7.3 feet); six in ironwood (*Olneya tesota*) (av. 10.6 feet); two in mesquite (*Prosopis juliflora*) (av. 6.5 feet); two in catclaw (*Acacia greggii*) (av. 6.0 feet); one in bitter condalia (*Condalia globosa*) (8 feet); and one on a broken saguaro stump (6 feet). Two of the nests in ironwood trees were placed in clumps of mistletoe and mark the only instances (except one Mourning Dove, *Zenaidura macroura*) of this plant being utilized as a nest site. The fruiting season for this plant was waning by this time, so the usual attraction of birds to these sites for food was negligible. This food attraction may account for the reluctance of earlier nesting species to utilize the excellent cover afforded by the mistletoe.

By late August and early September most of the White-winged Doves had either left the nesting grounds entirely or were moving about seeking out the available food.

Ground Dove (*Columbigallina passerina*).—The single nest of this species was found in a dead catclaw tree, partly uprooted and extending out over a large wash. The nest was typically dovelike in appearance but more sturdily constructed and sparsely lined with grass. It was placed on the main trunk of the tree some six feet above ground and contained two eggs when found on May 30.

The first clutch hatched around June 1, and by June 6 feather development was evident on wings and tail. The young fledged by June 15. Thirteen days later the nest again contained two eggs. The second clutch probably hatched on July 1. Ten days later one young was frightened from the nest; the other left a day or two later. The nestling period for the first brood was less than 15 days, and the first bird of the second brood left the nest when it was not over 12 or 13 days of age. Neither the adults nor young were seen later, and this single instance marked the only record for the species during the study.

Costa's Hummingbird (*Calypte costae*).—A single nest was found in Arch Canyon (Ajo Mountains) on May 1, when it contained one newly hatched young and one egg. It was located in a Palmer's oak (*Quercus palmeri*) on the tip of a limb five feet above ground. The nest was placed within six feet of the vertical canyon wall which shaded the structure during the day, except at high noon. The activity at the nest was observed closely for the next three hours and 17 minutes. During this period the female was on the nest during 13 attentive periods ranging in length from one to 25 minutes, averaging 12.7. The 13 inattentive periods were much shorter, lasting from one to five minutes and averaging only 2.6. Fifty minutes after observations started the young bird apparently was fed nectar. After one hour and five minutes (11:06 a.m.) the second egg was broken in half with the young bird still in the larger end. Fifty-three minutes after the first feeding the young bird was fed again, and 28 minutes later the third feeding was administered. By 12:25 p.m., two hours and 25 minutes after the start of the observation, the second bird had emerged. During the last hour following the hatching of the second egg, one or both of the nestlings were fed twice, the second feeding coming 25 minutes after the first. In all five feedings were recorded, averaging 59.2 minutes apart. The shells were still in the nest at 1:15 p.m. when observations terminated.

Little fear was displayed by the adult, which allowed a hand to be moved within an inch of the nest before she would hop off and hover a foot or two away. All observations were made within three or four feet of the nest.

Gila Woodpecker (*Centurus uropygialis*).—Seven nest sites of this permanent resident were observed. One pair was beginning nesting operations on April 13 in a cavity some 30 feet up in an arm of a large saguaro. By April 20 the young birds could be heard for

several feet around the nest site. The young of the first brood fledged shortly after May 4, and the second left the nest soon after June 15.

Three pairs completed their first nestings around June 6. In two of these cases the second nestings were completed by July 22, and the remaining pair had successfully reared the second brood by July 19. Apparently a single brood was raised by two other pairs, these fledging about May 5 and July 8, respectively. All nest cavities were in saguaros and ranged from 25 to 30 feet above ground. The last active nest was recorded on July 27 with young about ready to fledge. Both sexes assisted in incubation and care of the young as was indicated for several other species of woodpeckers by Kendeigh (1952).

Say's Phoebe (*Sayornis saya*).—This species occupies an interesting niche in this region. Four of five nests were found in old wells or abandoned vertical mine shafts. The nests were placed on ledges or in crevices usually about five to seven feet down from the rim of the holes. The only exception was a nest in the garage at Monument Headquarters. In this instance the nest was placed on a support about 12 feet above the floor. This same nest was used during the previous season and for both nestings of 1949. Two clutches of five eggs each were hatched and successfully fledged. The young of the first brood fledged during the first week in April, and after a 10-day interval the second nesting began. The second set of eggs was present on April 25. The species was recorded from March through the month of June.

Verdin (*Auriparus flaviceps*).—Of 16 nests found, 14 contained clutches of four eggs, one had five eggs, and the other had three young when discovered.

Nests were placed from 2.5 to 7 feet above ground and near the periphery of a tree or bush. Branches extending over washes were commonly selected as nest sites. Palo verde trees provided nest sites for eight pairs, and two each were placed in condalia, catclaw, and cholla cactus (*Opuntia fulgida*). The other two nests were in desert hackberry (*Celtis pallida*) and ironwood.

One nest, placed six feet up in a catclaw tree, contained one egg on March 23. By March 27 the full complement of four eggs was present. At this time, during a 71-minute observation period, the female made six trips to the nest carrying feathers. On three occasions the female sang from within the nest in response to the song of the male.

The incubation periods lasted from 15 to 17 days and only the female was recorded as performing this duty. Steady incubation did not occur, at least in one instance, until after the clutch was completed.

The young stayed in the nest from 15 to 18 days. Three of the pairs were known to raise two broods. Nest construction was first noticed on March 8, and all nests were empty by June 6. Verdins are permanent residents of this area and were recorded throughout the study.

Cactus Wren (*Campylorhynchus brunneicapillum*).—Twenty-one of 22 active nests observed were in the cholla cactus. The other one was on an arm of a saguaro some 15 feet from the ground. Heights of the nests in the chollas ranged from 3 to 10 feet. Anderson and Anderson (1957) recorded a similar minimum nest height in chollas even though suitable sites at lower heights seemed available in both studies. As pointed out by Huey (1942), Curve-billed (Palmer's) Thrashers competed with Cactus Wrens for nest sites in this cactus.

Incubation lasted 17 days in two nests. In one case the clutch of three eggs was completed on March 29, and on April 16 the nest contained three newly hatched young. Incubation dates for the second nest were April 2 to 19, from completion of the set until all were hatched. The nestling period for six of the nests ranged from 17 to 20 days. The egg

number per clutch was three or four with about equal numbers of each. Three pairs raised a second brood. Nesting activities of this common permanent resident began in late March and continued until late June.

Curve-billed Thrasher (*Toxostoma curvirostre*).—Twenty-seven nests of this resident species were observed. All were in cholla cactus and ranged from 3.5 to 9 feet above ground. Nesting operations were under way by late February and continued until early August.

Sixteen of the 27 nests contained three eggs, eight had two, two had four, and one had a single egg. Of the five pairs known to have attempted two nestings, three used the same nest for both, but the other two pairs built new nests. The initial attempts of the latter two pairs, however, were unsuccessful. Both pairs had deposited incomplete clutches of two and three eggs for their first nesting before desertion. Three and four eggs, respectively, comprised the clutches of the second attempts. Another pair had two eggs in the first clutch and one in the second.

Incubation lasted between 13 (May 1 to 14) and 14 (March 7 to 21) days for two nests, and the young stayed in the nest for 17 and 18 days, respectively. The dates refer to the interval between the depositing of the last egg and the hatching of the last young. Bent (1948) gives 13 days as the incubation period and 14 to 18 days for the nestling period. The sexes share in incubation duties, as well as in the brooding and feeding of the young. During a one-hour observation period the male of one pair incubated for 19 minutes and the female, for 30 minutes. In a second pair, watched for two hours, the male incubated a total of 23 minutes; the female, 32 minutes.

One egg required two hours and 32 minutes for the hatching process, which occurred between 10:14 a.m. and 12:46 p.m., the warmest part of the day.

Black-tailed Gnatcatcher (*Polioptila melanura*).—One nest was found on March 19 in the final stages of construction. It was placed within the many-branched interior of a small condalia tree 4.5 feet above ground. Both adults were engaged in the building activity.

On March 23 the nest contained one egg, and by March 28 the complete clutch of five eggs was present. During a two and one-half hour observation period the male spent 55 minutes on the nest as compared to 19 spent by the female. The incubation period for this clutch was 14 days (March 28 to April 11), with only two of the eggs hatching. The last young fledged in 12 days. During one 60-minute observation period, the young, nine days old, were fed once every 8.5 minutes with both parents participating. On April 25 three fledged broods consisting of two, three, and four young were seen accompanied by adults. Gnatcatchers were commonly recorded from March through July.

Phainopepla (*Phainopepla nitens*).—Eight nests were located as follows: four in palo verde, two in catclaw, and one each in condalia and mesquite. They were placed from 4 to 15 feet high and were usually in the outer third of the tree. No nests were found in mistletoe, a common site according to Bent (1950); they were, however, always in the vicinity of a plentiful supply of these berries. Rand and Rand (1943) noted that the tree containing a nest usually had mistletoe berries growing as well. In my study most nests were placed in trees without mistletoe, but always adjacent to ones with the parasite.

Only the male was recorded in nest-building activities. One individual ceased his labors only to help his mate chase an intruding female from the vicinity. The female continued the chase and on another occasion gave chase alone to an intruding female. Rand and Rand (*ibid.*) recorded similar chasings by the female.

Six of the nests found contained two eggs, and the other two held three each. The first nest was under way by March 10 and the last young left a nest shortly after May 30.

The incubation period at two nests was 14 days (March 28 to April 11, and April 6 to 20). The young remained in these nests for 17 and 19 days. Only the female was seen to feed the young during an hour and 17 minutes of watching at one nest. The principal food of this species in the nesting season appeared to be the red berries of the mistletoe, and as soon as the young had grown large enough to eliminate the seeds they were fed almost exclusively on these fruits.

Some Phainopeplas apparently winter in this region for they have been recorded in every month of the year by Monument officials. They were common throughout my stay in the area.

Loggerhead Shrike (*Lanius ludovicianus*).—The single nest, found on April 19, contained six eggs. It was in a thick clump of dead mistletoe seven feet up in a palo verde tree. The eggs hatched between April 19 and 24, and the young had fledged by May 4. No other individuals were seen.

House Finch (*Carpodacus mexicanus*).—All of the 12 nests found were located in cholla cactus at heights varying from three to eight feet above ground. The first nests of this resident species were discovered on March 28, and active nesting continued until the end of June. Clutch sizes varied from three to five eggs; nine nests had four.

Length of incubation in two nests was found to be 12 days (March 29 to April 10) and the young remained in the nest 15 to 16 days. Evenden (1957), in a study made in California, similarly found an average clutch size of 4.4 eggs for 25 completed nests, an average incubation period of 13.17 days, and an overall average nestling period of 15.1 days in 11 nests.

In my study, the only case of parasitism by the Brown-headed Cowbird (*Molothrus ater*) was recorded in a nest of this species. On May 4, four eggs (second clutch) were present in this particular nest. Five days later a cowbird egg was in the place of one of the finch eggs which was found broken on the ground below. The House Finches deserted this nest before the eggs hatched. Few records of this species being parasitized by the cowbird are available. Apparently Hanna (1933) and Robertson (1931) have recorded the only other known instances of parasitism in this species.

Summary

During the summers of 1948 and 1949, 25 species of birds, representing 16 families, were known to nest in Organ Pipe Cactus National Monument, Arizona. Observations of 16 of these species are here briefly discussed, including information concerning nest sites, incubation, adult behavior, and breeding periods.

Literature Cited

Anderson, A. H. and A. Anderson

1957 Life history of the Cactus Wren. Part 1: winter and prenesting behavior. *Condor*, 59:274–296.

Bent, A. C.

1937 Life histories of North American birds of prey. *U. S. Nat. Mus. Bull.*, 167:viii + 409 pp.

1948 Life histories of North American nuthatches, wrens, thrashers, and their allies. *U. S. Nat. Mus. Bull.*, 195:xi + 475 pp.

1950 Life histories of North American wagtails, shrikes, vireos, and their allies. *U. S. Nat. Mus. Bull.*, 197:vii + 411 pp.

Evenden, F. G.

1957 Observations on nesting behavior of the House Finch. *Condor*, 59:112–117.

Hanna, W. C.

1933 House Finch parasitized by the Dwarf Cowbird and Black Phoebe nests occupied by House Finch. *Condor*, 35:205.

Hensley, M. M.

1954 Ecological relations of the breeding bird population of the desert biome of Arizona. *Ecol. Monogr.*, 24:185–207.

Huey, L. M.

1942 A vertebrate faunal survey of the Organ Pipe Cactus National Monument. *Trans. San Diego Soc. Nat. Hist.*, 9:353–376.

Kendeigh, S. C.

1952 Parental care and its evolution in birds. *Ill. Biol. Mono.*, 22:v + 356 pp.

Neff, J. A.

1940 Notes on nesting and other habits of the Western White-winged Dove in Arizona. *Jour. Wildl. Mgt.*, 4:279–290.

Rand, A. L. and R. M. Rand

1943 Breeding notes on the Phainopepla. *Auk*, 60:333–341.

Robertson, J. M.

1931 Some changes in the bird life of western Orange County, California. *Condor*, 33:204–205.

DEPARTMENT OF ZOOLOGY, MICHIGAN STATE UNIVERSITY, E. LANSING, MICHIGAN, OCTOBER 13, 1958

GENERAL NOTES

Leg-muscle formulae and systematics.—Nearly 90 years have passed since Alfred H. Garrod described differences in the thigh muscles which he thought would aid in determining the relationships among birds. His muscle formulae have become an integral part of the technical diagnoses of the families and orders of birds. Garrod's contribution in this regard was, indeed, a most significant one, but Hudson (1937. *Amer. Midl. Nat.*, 18:1–108) demonstrated over 20 years ago that Garrod's formulae may be misleading because they often do not report adequately the similarities or dissimilarities in the thigh musculature, that is, the formulae are incomplete. Nevertheless, many contemporary writers continue to use Beddard's (1898) *The Structure and Classification of Birds* (or equally outdated references) as their source for myological data in order to support a thesis or to enlarge a technical diagnosis. In certain instances the addition of such formulae is merely padding; it has no real significance.

The opportunities for further work on avian myology are unlimited. For example, in addition to all of the genera that have never been studied at all, we need to have data on the complete appendicular myology of most of the genera that were studied in the past, in order that we may know more about the similarities and dissimilarities in their myology, including especially the muscles that Hudson proposed be added to the leg-muscle formulae.

I believe that muscle formulae can continue to be a useful part of the technical diagnosis *but only if the formulae are enlarged.* Hudson's excellent suggestions for expanding Garrod's original formulae were based on a study of representatives of North American bird families. If we think in terms of world birds, however, I believe that the addition of several other muscles would make the formulae even more meaningful. I would like to emphasize, however, that a muscle formula is only a substitute for knowing the complete appendicular myology. Perhaps the chief value in expanding the formulae is to call attention to those muscles that seem to exhibit the greatest variability among birds, and thereby to insure that authors will comment specifically on the presence or absence of those muscles when describing the anatomy of a given genus or species. When the author of an anatomical paper does not mention a particular muscle, one cannot be sure whether the muscle is absent or whether the author did not feel that it was important to refer to the muscle, simply because it is not one of the formulae muscles.

I have discussed M. iliacus at some length in a paper still to be published. I propose that M. iliacus be added to muscle formulae and that the presence of the muscle be indicated by adding "E" to the formula. I propose, further, that two other muscles be added. M. plantaris ("F") is absent in the Accipitridae, Pteroclidae, Psittacidae, Strigidae, Apodidae, and Bucerotidae. M. popliteus ("G") is absent in the Psittacidae, Apodidae, *Aceros undulatus*, Picidae, and in all passerine birds thus far studied. So little has been published on the total myology of the pelvic appendage, however, that it hardly seems necessary to say that we have no idea whether or not these two muscles are absent in all members of the Apodidae, for example, or in how many additional families or genera the muscles may be absent.

Mitchell (1913. *Proc. Zool. Soc. London*: 1039–1072) described M. peroneus longus and M. peroneus brevis in representatives of many families of birds. Either muscle may be absent in some birds. Hudson did not feel that it would be worthwhile to add these muscles to the formulae, and I agree with him, but probably for different reasons. There are several other muscles about which so little is known that we have no way of predicting whether or not it would be advantageous to add them to the formulae. For example, M. flexor hallucis brevis is absent in *Gavia*, *Uria*, and in some, but not all, passerines. M.

extensor hallucis longus is absent in *Gavia*, *Podiceps*, and *Uria*. M. extensor proprius digiti III is absent in such distantly related birds as *Fregata*, *Grus*, *Tyrannus*, *Corvus*, and *Sturnus*. M. adductor digiti II is absent in *Pediocetes*, some cuckoos, *Colaptes*, *Dendrocopos*, *Tyraunus*, *Paradisaea*, *Corvus*, *Fregilupus*, *Sturnus*, *Aplonis*, *Artamella*, *Vireo*, *Junco*, etc. Is M. extensor brevis digiti IV absent in *all* woodpeckers and passerines?

The full muscle formula as found in a galliform bird, for example, would be ABCDEFGXYAmV. We may tabulate these as follows:

Code Letter	Name of Muscle
A	Piriformis, pars caudofemoralis (= femorocaudal)
B	Piriformis, pars iliofemoralis (= accessory femorocaudal)
C	Iliotrochantericus medius
D	Gluteus medius et minimus (= "piriformis" of Fisher)
E	Iliacus (= "psoas" of Fisher)[1]
F	Plantaris
G	Popliteus
X	Semitendinosus (= "flexor cruris lateralis" of Fisher)
Y	Accessorius semitendinosi
Am	Ambiens
V	Vinculum between the tendons of Mm. flexor perforatus digiti III and flexor perforans et perforatus digiti III[2]

[1] M. iliacus of Fisher equals M. iliotrochantericus anterior of Hudson and Berger.
[2] It should be noted that the vinculum mentioned by Garrod, Forbes, Beddard, and Gadow usually pertains to the band that connects the tendons of Mm. flexor hallucis longus and flexor digitorum longus and which is found in most non-passerine birds. The vinculum of the formula above is far more variable among birds.

When the information above is available for all families of birds, we shall have a much better understanding of the significance of muscle formulae in determining the relationships among birds. I grant that this is a sizable list of symbols, and that the skeptic might counter with the statement that anatomists soon will propose that the entire alphabet be used in muscle formulae. However, I submit that systematists might better ignore muscle formulae entirely than to continue to use only Garrod's abbreviated formulae of AXYAm and ABXYAm.—Andrew J. Berger, *University of Michigan Medical School, Ann Arbor, Michigan, November 8, 1958.*

Tufted Titmouse feeding on a shrew.—On February 20, 1958, in the backyard of my parents' home in Van Buren County, Michigan, I watched a Tufted Titmouse (*Parus bicolor*) eating bits of flesh which it picked from a Masked Shrew (*Sorex cinereus*) during a heavy snowfall. The bird had lodged the little mammal in a forked branch of a small shrub just above the ground and was holding it there by one foot while clinging to the branch with the other. As I approached to a distance of about 10 feet the bird flew to a nearby apple tree with the shrew in its bill and continued feeding. I was not able to determine whether the titmouse had captured the mammal alive or found it dead.

An examination of pertinent literature failed to disclose any mention of this species including small mammals as part of its diet. Perhaps the greater than average snowfall had created a decline in the availability of the regular food supply and caused the bird to turn to such an unusual meal.—Richard C. Fleming, *136 E. Battle Creek Street, Galesburg, Michigan, May 15, 1958.*

Scissor-tailed Flycatcher in northern Minnesota.—On October 23, 1958, we collected a Scissor-tailed Flycatcher (*Muscivora forficata*) near the northeast corner of the Forest Research Center, 1260 feet elevation, about three miles west of Cloquet, Carlton County, Minnesota. This bird, a male with double-layered skull, proved to be moderately fat, weighing 51.0 grams, and having testes 3 mm. long. The skin has been deposited at the Minnesota Museum of Natural History, Minneapolis (MMNH no. 14562). The occurrence of the bird in this area was coincident with the arrival of Snow Buntings (*Plectrophenax nivalis*) and Northern Shrikes (*Lanius excubitor*) from the north.

This record appears to constitute the fourth reported occurrence of this species in Minnesota, and the first occurrence verified by an extant specimen. Earlier records (Roberts, 1932. "Birds of Minnesota," 2:11) are based on a bird collected near New London in the central part of the state prior to 1912, but subsequently lost; a sight record of a bird, "about two miles north of the Iowa line—" south of Lakefield, June 5, 1930; and two sight records of a single bird (Kelly, 1958. *Flicker*, 30:57) on the south shore of the Lake of the Woods in extreme northern Minnesota on July 3 and 7, 1957.—Gordon W. Gullion and Bruce A. Brown, *Forest Research Center, University of Minnesota, Cloquet, Minnesota, November 25, 1958. (Paper No. 992, Miscellaneous Journal Series, Minnesota Agricultural Experiment Station, St. Paul 1, Minnesota.)*

Interaction between a feral parakeet and House Sparrows.—An escaped Australian Shell Parakeet (probably *Melopsittacus undulatus*) was observed with a flock of approximately 30 House Sparrows (*Passer domesticus*) on the campus of Western Michigan University. I saw the pale-blue parakeet feeding with and flying with a flock of sparrows on four occasions in the month of November, 1958. In none of these instances was there any sign of interspecific strife between the parakeet and the sparrows; seemingly, the parakeet was well-integrated into the aggregation.

On two other occasions I saw the parakeet separate from, but near, a flock and observed its interaction with individual sparrows. On the first occasion a male sparrow detached itself from the flock of sparrows feeding on the ground, flew approximately 50 feet, and attacked the parakeet where it was perched alone in a low shrub next to a campus building. The parakeet flew and was chased some 20 yards by the sparrow before it returned to the flock. On the second occasion a female sparrow flew and ran at the parakeet when both parakeet and sparrows were feeding on the lawn; in this case the parakeet was searching and feeding alone some 20 feet from the closely-packed, feeding sparrows.

Seemingly, the sparrows tolerated the parakeet when it was a part of the aggregation, but treated it in a hostile manner when it was not a part of the flock.—Thane S. Robinson, *Department of Biology, Western Michigan University, Kalamazoo, Michigan, December 23, 1958.*

Yellow-breasted Chat parasitized by tick.—While banding with Dr. Paul Fluck at Washington Crossing Park during the early part of May, 1958, we captured a Yellow-breasted Chat (*Icteria virens*) which had a tick, much enlarged with blood, attached to its neck. The tick was removed and identified by Dr. Fred Truxal, entomologist of the Los Angeles County Museum, as an *Ixodes muris* of the family Ixodidae. This tick has been recorded from several mammalian hosts, but not from birds. These recorded hosts are of the following genera: *Blarina, Peromyscus, Microtus, Ondatra, Rattus,* and *Zapus.*—Don Bleitz, *Bleitz Wildlife Foundation, 1001 North McCadden Place, Los Angeles 38, California, July 28, 1958.*

Foster-feeding and polygamy in the Purple Martin.—While conducting homing experiments with Purple Martins (*Progne subis*) in the vicinity of the University of Michigan Biological Station, Cheboygan County, Michigan, in the summer of 1958, I trapped, color marked, and released 16 adult martins at distant points. When periodically checking for the return of these homing birds I also observed behavior at the nests.

Female 14 was trapped at 3:30 p.m., July 11, and was released near Sleeper Lake, Luce County, Michigan, at 9:00 p.m. the same day. She did not return to the nest until the afternoon of July 13. In her absence the female occupying the nest directly above made several trips to Female 14's nest with food for the young. This female also continued to care for her own young. Perhaps the begging notes of the young in the nest below induced her to bring food. Number 14's mate was also feeding his young. He accepted this help and did not attempt to drive away the assisting female. When Female 14 returned, the assisting female ceased this behavior and cared solely for her own brood. This was my only observation of foster-feeding, although 14 females were taken from the colony for periods of a few hours up to approximately three days.

I also recorded an instance of possible polygamy. Females 9 and 10 were removed from the colony for homing trials. The nest compartments of these two birds were side by side. During their absence, a single male cared for both broods of young. Often he brought several insects to the nests and fed some to each brood. Sometimes all of the food was given to one brood of young and a fecal sac removed. No challenging martin came to either of these nests. Female 9 was absent from the nest for eight hours and No. 10 was gone for 25.5 hours. The male was successful in his attempt to care for two broods because young fledged from both nests.—William E. Southern, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan, October 8, 1958.*

New bird records for St. Croix, Virgin Islands.—To that increasing list of migratory warblers recorded from St. Croix, Virgin Islands, must now be added yet another, the Yellowthroat (*Geothlypis trichas*).

At dawn on April 4, 1958, a clear, loud and unknown *witchity-wichity-witchity* came from a tree outside my window. Upon investigation of this new call a small bird was seen to fly a short distance away to a scrub thicket. "Squeaking" soon brought the singer within gunshot, and I collected it. Since this warbler was badly mutilated, the skin was forwarded to Mr. James Bond, at the Philadelphia Academy of Sciences, for corroboration of my identification.

In a letter dated August 24, 1958, Mr. Bond wrote: "Your specimen is an immature male in the process of acquiring adult breeding plumage. Although recorded from Tobago, it is the easternmost record from the Antilles."

With few exceptions the birds added to the list of new records from the Virgin Islands have been small and insignificant creatures, unobtrusive in drab autumnal anonymity.

Six tall Glossy Ibis (*Plegadis falcinellus*), feeding in a small, fresh-water pond located at Williams (West End), St. Croix, were neither small nor difficult to identify.

These ibis were first observed on the morning of September 15, 1958. By October 2, only three birds could be found. These were observed almost daily until October 10, when another attempt to obtain a specimen scared them away. They took off in a northwesterly direction and were not again seen.

The only previous record for this ibis from the Virgin Islands is one by John Furth (James Bond, in litt.), who reported it from Krum Bay and Stumpy Bay, St. Thomas. No dates are given.—G. A. Seaman, *Post Office Box 474, Christiansted, St. Croix, U. S. Virgin Islands, November 20, 1958.*

Nesting concentration of Long-eared Owls in Cochise County, Arizona.—On April 16, 1956, I found a nest of the Long-eared Owl, (*Asio wilsonianus*), on the John Sala ranch, about 12 miles north of Tombstone, Cochise County, Arizona. Between April 16 and June 8, 1956, six nests of owls of this species were found within a diameter of 3 miles.

The elevation of the ranch at the mouth of Granite Springs Canyon is 5190 feet; it lies in the foothills on the south slope of the Dragoon Mountains. The predominant vegetation consists of grasses with scattered yuccas and mesquite; there is an extensive area of live oaks west of the ranch house and along Granite Springs Canyon. All nests were found in this live oak area. The nests used by the owls were apparently old ones of Ravens (*Corvus corax*) or Cooper's Hawks (*Accipiter cooperii*). The nesting area is in the Grassland Subzone of the Upper Sonoran Life Zone, as delimited roughly by the 4000- to 5000-foot elevation.

The first nest (April 16) was situated approximately 50 to 55 feet up in an Emory oak (*Quercus emoryi*) in oak woods along the dry stream bed near the mouth of Granite Springs Canyon. Besides the dominant Emory oaks, trees consisted of Arizona white oak, (*Quercus arizonica*), velvet ash, (*Fraxinus velutina*), and a scattering of Arizona walnut (*Juglans major*), western hackberry (*Celtis reticulata*), western box-elder (*Acer Negundo* var. *interius*), and alligator juniper (*Juniperus deppeana*). Thick grape tangles near the nest were used by the owls as a roosting place. A Cooper's Hawk nested in an oak about 100 feet from the owls' nest. Nests of Black-chinned Hummingbirds (*Archilochus alexandri*) and the Common Bushtit (*Psaltriparus minimus*) were observed in the vicinity.

The owls' nest found on April 16 held three downy young which were standing up and stretching their wings. An adult lay on the edge of the nest. It did not flush as I moved about underneath. On April 27, the young were still in the nest. By May 6, the nest was empty; and on May 8, one young was perched near the nest, and the other two in nearby trees. On May 28, the young were still about the nest and were flying well, but on June 5, the family could not be located.

Nest no. 2 was found on April 23, about one-fourth mile down Granite Springs Canyon from the first. It was 18 or 20 feet up in an Emory oak in an isolated clump of oaks on a high bank above the stream bed. There were three young in the nest and one smaller dead one under the tree. This nestling was probably only a week old or less because it still retained its egg tooth. This chick (a female) was prepared as a study skin, and is now in the collection of Dr. Allan R. Phillips. On April 27, when I climbed a nearby tree to photograph the nest, one young jumped from the nest to the ground. After photographing this bird, I placed it up about seven feet in the nest tree; it eventually reached the nest. On May 2, the nest was empty, and several days later the young were located in nearby oaks.

Nest no. 3 was located on May 3, approximately 20 feet up in an Emory oak in a wash with a scattering of oaks, mesquite (*Prosopis juliflora*), (*Yucca* sp.), and beargrass (*Nolina microcarpa*) in the vicinity. A dead adult Long-eared Owl and one small live downy young were on the ground beneath the nest. I placed the young owl in the tree but it did not survive. The other parent was not seen.

Nest no. 4 was situated in an isolated group of oaks in a little valley in the grasslands. This nest was about a mile and one half from Nest no. 2. It was 20 feet up in an Emory oak and contained four downy young on May 10. When I first approached the nest an adult flushed from the nest and flew to the ground where it uttered the characteristic cat calls and flapped its wings. It also dived at me every time I neared the nest. These were the only adults of the six pairs that behaved in this manner. A Cooper's Hawk nested in

an oak some 200 feet from the owls' nest. On several occasions the hawk was seen to leave its nest and chase the owls as they flew about. This was the only friction noted between the two species. On May 15, while I was climbing the tree to photograph the young, two of them jumped from the nest, one landing on a lower limb, the other on the ground. I later placed this latter nestling up in the tree with the other young owl. The wing feathers of this nestling were slightly over two inches out of their sheaths, and the tail measured one inch from the sheaths. The black facial disks were beginning to turn brown. On May 21, the nest was empty, and none of the young could be found. It was not until June 8 that an adult and the four young were flushed from a roost in a nearby oak.

Nest no. 5, located on May 10, was 18 to 20 feet up in an Emory oak in a group of oaks in a wash. It was about a mile or more from Nest no. 3. Three young were flushed from adjoining oaks, and on May 18, there were four adult-sized young in a tree near the nest. The nest was much smaller than the other owl nests, being about the size of a Roadrunner's (*Geococcyx californianus*) nest.

On June 8, I found Nest no. 6, 15 feet above ground in an Emory oak in a clump of oaks along a wash. An adult and two large young were in nearby trees.

During the study, I collected about 73 Long-eared Owl pellets that were found under roosts near the nests. I am much indebted to Mr. John R. Mikita, Department of Zoology, University of Arizona, for analyzing this material for me.

The following species were identified in the pellets:

Species	No. of Individuals
Notiosorex crawfordi, Desert Shrew	7
Thomomys bottae, Valley Pocket Gopher	2
Perognathus flavus, Silky Pocket Mouse	8
Perognathus penicillatus, Desert Pocket Mouse	11
Perognathus sp.	193
Dipodomys merriami, Merriam Kangaroo Rat	19
Dipodomys ordi, Ord Kangaroo Rat	7
Dipodomys sp.	5
Reithrodontomys megalotis, Western Harvest Mouse	4
Peromyscus eremicus, Cactus Mouse	10
Peromyscus sp.	14
Onychomys torridus, Southern Grasshopper Mouse	33
Neotoma albigula, White-throated Wood Rat	1
Bird ("a small junco-type")	1

In the western United States, concentrations of nesting Long-eared Owls have been reported for California and Utah, but not for Arizona (Bent, 1938. *U. S. Nat. Mus. Bull.*, 170:155–156). In fact, this owl has previously been considered a rare breeder in Arizona. Seven of the nine other known breeding records are for southeastern Arizona (Pima and Cochise Counties).

The Long-eared Owl has an extended nesting season in Arizona. The previous records indicate this as well as my own observations. Two examples will suffice: Dr. Mearns collected a female from a "Cienega" 10 miles west of Camp Verde in north-central Arizona on February 20, 1886, which according to his MS., "was about to lay eggs." A. J. van Rossem writes (1936 *Trans. San Diego Soc. Nat. Hist.*, 8:134) of a "family of these owls in the mesquite (Lower Sonoran Zone) along the dry stream bed at Bates Well. The young were nearly full grown, but partly in juvenal plumage. One specimen, a juvenal male, was collected on June 23, 1932."

In a habitat dissimilar to the Emory oak situation, C. M. Palmer, Jr., of Tombstone, found a nest near Lewis Springs on April 27, 1955. The nest was in a mesquite and held three downy young. The vegetation was creosotebush and black brush association. He found another nest on March 23, 1957, in a desert hackberry in a dry wash, about eight miles north of Tombstone, but he gave no details of the contents of this nest (Letters, March, 1957).

The nesting season of the owls in 1956 was lengthy. The family of Nest no. 2 were out of the nest on May 2, while Nest no. 3 held a downy young on May 3. The young of Nest no. 4 were still in the nest on May 10; on the same date, the young of Nest no. 5 were on the wing.

In the vast plains and mountains of Arizona, the Long-eared Owl might easily be overlooked when we consider the fact that ornithologists are a rarity in the region. More intensive field work in the nesting season would probably reveal more nests. Two factors which seem to me to account for the concentration of owls in this small area were the availability of many nesting sites and the apparent abundance of small mammals.

I wish to thank Dr. Allan R. Phillips for his criticism of the manuscript and for the early records; C. M. Palmer, Jr. for his records; John R. Mikita for analyzing the pellets; and Mr. and Mrs. John P. Sala for their many kindnesses to me while I was at their ranch. Without their combined help, this study would not have been completed.—John J. Stophlet, *2612 Maplewood Avenue, Toledo 10, Ohio, January 13, 1958.*

A Palm Warbler in Oklahoma.—On April 26, 1958, I collected a specimen of the Palm Warbler (*Dendroica palmarum*) in a wooded section of Bird Creek bottom land, three miles northeast of Tulsa, Tulsa County, Oklahoma. I found the bird preening in a small tree approximately five feet above the ground. It was alone and was not singing.

Nice (1931. *Publ. Univ. Okla. Biol. Surv.*, 3) lists the Palm Warbler as a rare transient in eastern Oklahoma, noting that no specimen had been taken in the state at that time. I have found no record of a specimen taken here since then.

In this male the testes were somewhat enlarged, 3 mm. in diameter. It was moderately fat with measurements as follows: wing length (chord), 66 mm.; tail length, 52 mm.; length of exposed culmen, 12 mm. The pre-nuptial molt of the head and throat region was in progress. Several bright yellow feathers on the throat were sheathed.

On the basis of plumage color, it appeared to belong to the western race (*Dendroica palmarum palmarum*). This was verified by Dr. George M. Sutton at the University of Oklahoma Museum of Zoology where this specimen is now No. 3355.—John S. Tomer, *4045 East 27th Street, Tulsa, Oklahoma, September 10, 1958.*

ORNITHOLOGICAL NEWS

The 1959 meeting of the Wilson Ornithological Society will be held in Rockland, Maine, June 11–14, at the Farnsworth Museum. This is the first New England meeting of the Wilson Society, and it is being held at the invitation of the Portland Society of Natural History, the Farnsworth Museum, and the Maine Audubon Society. Co-chairmen of the local committee are: Christopher M. Packard (Director of the Portland Society of Natural History) and Wendell Hadlock (Director of the Farnsworth Museum).

Preliminary plans for the program include a Wood Warbler Symposium, led by Dr. George M. Sutton; a Migration Symposium, led by Chandler S. Robbins; and a Banding Symposium, led by James Baird. It is hoped that the Migration Symposium may present the first films showing radar observations of North American migrants. Plans also include a sea trip to Matinicus Rock to observe puffins and other sea birds. There will also be a field trip to Mt. Desert Island.

Further details will be mailed to members in due course. Meanwhile, advance inquiries regarding the Rockland meeting may be addressed to: Mr. Christopher M. Packard, Portland Society of Natural History, 22 Elm Street, Portland, Maine.

The Wilson Ornithological Society is indebted to Don R. Eckelberry for making available the painting of the Black-throated Trogon from which the frontispiece was reproduced.

The next annual meeting of the American Ornithologists' Union (A.O.U.) will be held at the Saskatchewan Museum of Natural History, Regina, August 25–30, 1959.

Mrs. A. C. Bent has presented the library of her late husband, Arthur Cleveland Bent, to the University of Massachusetts.

The library will be housed as a memorial unit in the new nine-million-dollar Science Center currently under construction. The section of the Science Center containing the reading room should be opened by February, 1960, and the library should be available for use by interested ornithologists soon thereafter. It is planned to keep adding to the library to make it a "living" memorial to Mr. Bent.

The University of Oklahoma Biological Station announces a new course in Animal Behavior (Zoology 309) to be offered during the 1959 summer session. The field and laboratory phases of this course will emphasize the local fauna. This will be a three-credit-hour course designed for upperclass and graduate students.

The Biological Station is situated on Lake Texoma in south-central Oklahoma. There is a rich vertebrate and invertebrate fauna in this area available for behavior studies. Research programs in animal behavior by the staff, graduate students and private investigators at the Biological Station have involved all classes of vertebrates and some invertebrates. The necessary facilities and equipment for field and controlled behavior studies are available or can be obtained.

Persons interested in this course or in the Biological Station should write to Dr. Carl D. Riggs, Director, University of Oklahoma Biological Station, Norman, Oklahoma.

The Division of Biological and Medical Sciences of the National Science Foundation announces that the next closing date for receipt of basic research proposals in the life sciences is May 15, 1959. Proposals received prior to that date will be reviewed at the summer meetings of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after the May 15, 1959, closing date will be reviewed following the fall closing date of September 15, 1959.

Inquiries should be addressed to the National Science Foundation, Washington 25, D. C.

WILSON SOCIETY MEMBERSHIP COMMITTEE

The Wilson Society membership is not growing, and the society officers solicit the aid of all members in correcting this situation. If you know of any good prospects, please send their names to the committee member from the appropriate state. Where the state is not represented, names may be sent to the chairman. With the 1959 convention in Maine, we have hopes of increasing the New England membership, and names from this region are particularly desired.

James Baird, Norman Bird Sanctuary, Third Beach Rd., Newport, R. I.
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J. H. Ennis, Cornell College, Mt. Vernon, Ia.
Earl W. Farmer, 611 N. 4th St., Steubenville, Ohio
G. E. Grube, State Teachers College, Lock Haven, Pa.
Charles W. Hamilton, 2639 Fenwood Rd., Houston 5, Tex.
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L. R. Mewaldt, Dept. Natural Science, San Jose State College, San Jose, Calif.
Lawrence R. Penner, Dept. Zoology and Entomology, Univ. of Conn., Storrs, Conn.
Jennie Riggs, 2005 Capers Ave., Nashville, Tenn.
John P. Rogers, Wildlife Bldg., Univ. of Missouri, Columbia, Mo.
Stephen W. Simon, Blue Mount Rd., Monkton, Md.
Doris H. Speirs, "Cobble Hill," RD No. 2, Pickering, Ontario
Howard Young, Wisconsin State College, La Crosse, Wis., Chairman

NEW LIFE MEMBER

Mrs. Robert V. D. (Kay F.) Booth, a member of the Wilson Ornithological Society since 1949, resides with her husband and two boys in Painesville, Ohio. Along with many family activities she finds the time to talk before adult and youth groups on bird study and conservation, to band birds, and to participate in the work of the Blackbrook Audubon Society (recently President) and the Cleveland Audubon Society (formerly Editor of the *Cleveland Audubon Bulletin*; now Vice-President and one of the bird walk leaders). She enjoys attending annual meetings of the Wilson Society, as well as those of the American Ornithologists' Union and Cooper Ornithological Society to which she belongs. In 1954 she attended the Eleventh International Ornithological Congress in Switzerland.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

Andrew J. Berger—1 reprint
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Texas Ornithologists' Society—3 newsletters
Harrison B. Tordoff—1 phonograph record
George Willoughby—66 journals
Wisconsin Conservation Department—1 pamphlet
Wisconsin Society for Ornithology—11 journals, 17 reprints
University of Wisconsin, Department of Wildlife—2 reprints
Howard F. Young—1 reprint
Richard L. Zusi—76 journals

ORNITHOLOGICAL LITERATURE

The Bird Life of Great Salt Lake. By William H. Behle. University of Utah Press, Salt Lake City; 1958: 9½ × 6¼ in., (12) + 1–203 pp., 43 figs., 28 tables. $4.50.

The reader who buys by title alone will be surprised when he opens this book. The subtitle, "The life history, ecology and population trends of the California Gulls, White Pelicans, Double-crested Cormorants and Great Blue Herons, together with an account of the Bear River Migratory Bird Refuge," is more indicative of the contents of the book than is the title.

As the subtitle suggests. Professor Beble's book is principally a presentation of information concerning the natural history of four species of colonial-nesting birds found on islands in Great Salt Lake. This information comes from some 25 years of field work by Behle, and others, in the area, and an exhaustive review of the literature.

Following an account of each of the islands studied, the California Gull is treated extensively under such headings as geographic range, seasonal status, flight, time of nesting, nests, egg laying, incubation and behavior at nesting sites, dispersal of young, migration of adults, the plumage cycle, homing instinct, etc. There then follows a similar, but less extensive, section on the White Pelican. The Double-crested Cormorant and the Treganza Great Blue Heron are each treated in a brief chapter. The small breeding population of Caspian Terns is considered briefly, as are a few of the birds occurring on the waters and shores of the lake. A list of birds, other than those that nest in colonies, is presented for each of the islands included in the study. The chapter on the Bear River Refuge includes a check-list of 198 species and subspecies of birds recorded at the Refuge by its personnel. An excellent list of literature cited by the author follows the text. There is no index.

Objections concerning the book are few, and of minor significance. The maps (Figures 2, 24, and 43) have no scale of miles, and Oklahomans may feel slighted by the omission of their state from the map on page 91. Particular figures, most of which are excellent half-tones, are difficult to find due to the omission of page numbers from the list of illustrations. Behle's use of "nuptial plumage" may draw some criticism; he points out that the California Gull reaches maturity in three years, but he speaks of nuptial plumages in the first and second years.

The book is to be recommended to those interested in the avifauna of Great Salt Lake and its environs, and particularly to those interested in the natural history of gulls, pelicans, cormorants and herons.—Thane S. Robinson.

Arctic Birds of Canada. By L. L. Snyder. University of Toronto Press, Toronto, 1957: 6 × 9¼ in., x + 310 pp., illus. $4.75.

This book has far more to offer than the title and the author's precise delineation of its scope might indicate. It is a fascinating guide to a fascinating group of birds, and the information contained within its pages is of value to amateur or professional ornithologists whether they visit the arctic regions or not. Even the author's appraisal of the book as being not one having appeal as a literary companion would not be true if it weren't for the interminably long passages that perhaps reduce the number of pages, but make it hard to keep one's eyes open.

In the introductory chapter the author has established the limits of the Canadian Arctic as defined by him, given the objectives of the text, discussed the process of identification through elimination, provided a key to the orders of birds of the Canadian Arctic, made a

broad classification of arctic habitats and the birds most likely to be found in these habitats, and has written a short but well-done summary of the nature of arctic birds. While the order key is little affected, I personally object to using other than a dichotomous means of separation. His separation of the Gruiformes, Charadriiformes, and Galliformes is done by a triplet rather than a couplet method.

There are nine orders covered in the main body of the text and each family discussed under these orders is given a general discussion on features that distinguish the particular family. Here will be found information, though aimed primarily at the amateur, that will often provide quick reference for the professional. Following the general discussion, each species is described under the following categories: additional names, status (general, arctic, migratory), habitat, characteristics and remarks. A most interesting feature useful to visitors of arctic regions has been the inclusion of the Eskimo names for each bird species. The section on characteristics often occupies three or four pages and includes features seldom found in identification guides. This section describes the appearance of the adult in the field and when held in the hand. It describes the young in the field, in the hand, and also in the down. The eggs and the nest are also detailed. The remarks section is primarily devoted to problems of classification and distribution.

In addition to the main text there is an appendix list of bird species that are not characteristic of the Canadian Arctic, but whose occurrence is occasional, a fairly complete glossary, a partial bibliography of some 52 titles, and a good index.

The publishers are to be congratulated on the appearance of the book and its freedom from typographical errors, and a review would be incomplete if mention was not made of the illustrations that are of the usual high quality that we have come to expect from T. M. Shortt.—P. B. Hofslund.

This issue of *The Wilson Bulletin* was published on March 11, 1959.

Editor of The Wilson Bulletin

H. LEWIS BATTS, JR.

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Kalamazoo College
Kalamazoo, Michigan

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Suggestions to Authors

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (Fifth Edition, 1957) insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A Word to Members

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the "suspended list." Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The *Bulletin* will become larger if members will make a point of paying their dues promptly.

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If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He will notify the printer and editor.

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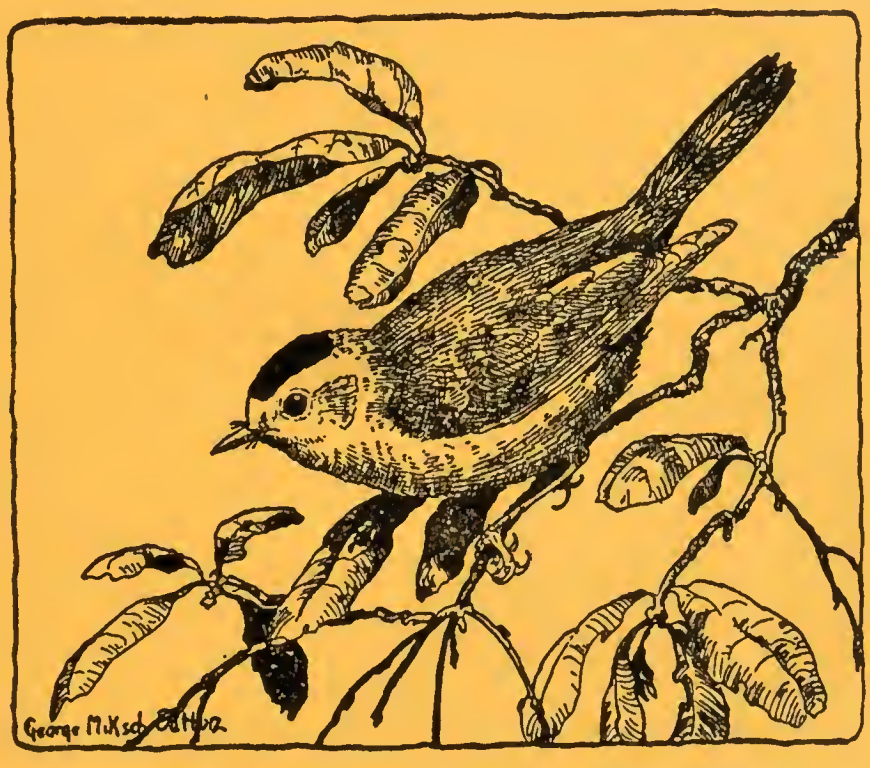

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THE WILSON BULLETIN

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All articles and communications for publication, books and publications for review should be addressed to the Editor. Exchanges should be addressed to The Josselyn Van Tyne Memorial Library, Museum of Zoology, Ann Arbor, Michigan.

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Specimens of woodpeckers from central Texas in dorsal (above) and lateral (below) view. From left to right, male and female *Centurus aurifrons*, male and female *C. carolinus*, and female *Melanerpes erythrocephalus*.

INTERSPECIFIC RELATIONS OF WOODPECKERS IN TEXAS

BY ROBERT K. SELANDER AND DONALD R. GILLER

Concrete information on ecologic relations of closely related species is infrequently reported, especially in this country. A small number of documented cases of interspecific territorialism in birds is known (see review by K. E. L. Simmons, 1951; also. Pitelka, 1951; Legg and Pitelka, 1956; Dixon, 1950, 1954), but many additional data will be needed before the full significance of this phenomenon, with respect to species' distribution, numbers, and evolution, can be evaluated.

This paper is a preliminary report of studies on territorial and other relations of three woodpeckers in the Austin region, central Texas. The subjects are the Red-bellied Woodpecker (*Centurus carolinus*), Golden-fronted Woodpecker (*Centurus aurifrons*), and Red-headed Woodpecker (*Melanerpes erythrocephalus*). The data herein reported were gathered, more or less irregularly, over a period extending from spring, 1957, to spring, 1958.

Relations of *C. carolinus* and *C. aurifrons*

The following notes on the systematic and ecologic relations of *C. carolinus* and *C. aurifrons* are prompted in part by a recent suggestion (Brodkorb, 1957) that the two may be conspecific. This is not the case, as they are sympatric without interbreeding in central Texas.

Distribution.—Centurus carolinus ranges west to central Texas and is replaced in the west and in the Panhandle by *C. aurifrons*. Apparently nowhere is there extensive overlap in ranges, but at least locally in south-central Texas they are sympatric. At Austin, Travis County, overlap is limited to a zone not more than 20 miles in width, and the two species may regularly be seen together only within the limits of the city itself. We have little to add at this time to G. F. Simmons' detailed account (1925) of the local distribution of these woodpeckers in the Austin region, which includes all of Travis County and parts of adjacent counties. The reader is also referred to G. F. Simmons' book for accounts of physiography, climate, and vegetation of the region. Climatically, Austin is intermediate between semi-arid regions to the south and west and mesic regions to the east. There is a marked east-west faunal and floral "break" in the Austin region, discussed by Blair (1950). Contact and hybridization between the eastern Tufted Titmouse (*Parus bicolor bicolor*) and a black-crested race (*P. b. atricristatus*) occur in the same region in which ranges of the *Centurus* woodpeckers overlap (Dixon, 1955).

C. carolinus is common throughout Austin and in the region to the east, especially in forest and woodland on the floodplain of the Colorado River; but, rarely has it been recorded even a few miles west of the city. In Austin, *C. aurifrons* is comparatively uncommon and localized in distribution, but pairs

may regularly be found in several places in the southern and western parts of town, as at Barton Springs; and it occurs in small numbers in central and eastern Austin, as in the City Cemetery a few blocks east of the campus of the University of Texas. West and, especially, south of Austin it is moderately common. At San Antonio, 80 miles south-southwest of Austin, it is common, and there are no records of *carolinus* (Attwater, 1892:235).

Both species are permanent residents in the Austin region. There is probably an influx of *C. carolinus* from the north in the winter, at which time it is more common than in the summer in timber on the floodplain of the Colorado River. However, the local distribution of both species is, by and large, similar in all seasons.

Neither species appears to be in the process of extending its range in Texas. Even the local distribution and relative abundance of these species in the Austin region apparently have not changed to any great extent within the last 33 years. Many of the specific localities for *carolinus* and *aurifrons* mentioned by G. F. Simmons in 1925 are those in which the species are found at the present time. As the city of Austin continues to expand, a decrease in numbers of *aurifrons* may be expected as tracts of mesquite, juniper, and oak are cleared west and south of town.

Morphologic Differences between Species.—In central Texas both species of *Centurus* are closely similar in size (Table 1) and in general appearance (frontispiece). The only conspicuous difference is in the color and pattern of the head. In the male *C. carolinus* the entire dorsal surface of the head is red; in the male *C. aurifrons* the nasal region is yellow, the nape is golden yellow, and a coronal patch of red is surrounded by gray. In the female *carolinus* the nasal region and nape are red, whereas these are yellow in *aurifrons*. In females of both species the coronal region is gray. The abdominal region is washed with red in *carolinus*; the belly may or may not have a suffusion of yellowish in specimens from eastern parts of the state (Burleigh and Lowery, 1944). This region is washed with yellow or golden yellow in *aurifrons*. There are also some minor differences in pattern of the upper tail coverts and inner webs of the central rectrices (see frontispiece).

Both species vary geographically in Texas. A series of *C. aurifrons* from the Texas Panhandle and Harmon County, Oklahoma, at the northern limit of the species' range, is considerably larger in all dimensions than birds from central and southern Texas. Specimens from Oklahoma have been referred to *C. a. incanescens* (A. O. U. Check-list, 1957:317), a race named from Brewster County, western Texas, and distinguished from *C. a. aurifrons* of southern Texas and México on the basis of minor color and pattern differences. However, specimens from Brewster County are small like those from central-southern Texas. Variation in size apparently was not considered by Wetmore

(1948) in his review of geographic variation in *Centurus aurifrons*, but it is apparent that there is a north-south cline in size in Texas, which may or may not be concordant with clines of variation in color and pattern.

TABLE 1

MEASUREMENTS (IN MM.) OF WOODPECKERS FROM TEXAS

	No.	Wing	Tail	Bill	Tarsus
			ADULT MALES		
C. aurifrons[1]	8	137.0 (132–140)	82.0 (76–85)	27.06 (24.9–28.8)	24.70 (24.0–26.0)
C. aurifrons[2]	8	129.7 (128–132)	77.1 (76–79)	25.80 (24.2–27.0)	22.20 (20.2–23.2)
C. carolinus[3]	6	129.0 (126–132)	76.4 (70–80)	24.35 (23.2–25.3)	21.22 (19.7–21.8)
M. erythrocephalus	3	140.0 (137–143)	80.0 (78–82)	22.93 (22.1–24.0)	22.10 (21.9–22.3)
			ADULT FEMALES		
C. aurifrons[1]	1	134	80	27.6	23.2
C. aurifrons[2]	6	127.8 (125–132)	73.7 (69–77)	23.48 (22.2–25.1)	22.53 (21.7–23.7)
C. carolinus[3]	4	125.7 (124–128)	73.3 (70–76)	23.30 (22.2–25.3)	19.90 (19.4–20.5)
M. erythrocephalus	1	141	72	22.5	22.8

[1] Texas Panhandle and Harman Co., Oklahama.
[2] Central–sauthern Texas fram Travis Caunty sauth.
[3] Central Texas fram Travis Caunty east ta Andersan County.

Specimens of *C. carolinus* from Austin and Houston southward reportedly are paler than those from northeastern Texas and have been distinguished racially, as *C. a. harpacens*, by Koelz (1954).

Habitat Occurrence.—Throughout its range in Texas, and also extensively in northern México, *C. aurifrons* inhabits xeric vegetation types in which mesquite is often a dominant element. At Uvalde, Uvalde County, and at Pearsall, Frio County, *aurifrons* is a common resident in mesquite woodland. In Palo Duro Canyon, northern Texas, it occurs in riparian cottonwoods and mesquite flats on the floodplain of the Prairie Dog Town Fork of the Red River. Characteristic habitat of this species south and north of Austin is a mixed oak, large mesquite, and juniper formation on gravel ridges extending from the Balcones escarpment for several miles into the black prairie soils east of Austin (see Dixon, 1955, Fig. 9 and p. 169). We have one record of *aurifrons* in this vegetation five miles east of Austin. In this formation *carolinus* is rarely found.

C. aurifrons also frequents pecan groves and other open situations on floodplains, and in small numbers it is found in live oaks, elms, and other mesic types in residential districts in Austin, especially where these are adjacent to stands of mesquite, deciduous oak, and juniper.

C. carolinus, in contrast, inhabits mesic formations, frequenting "dead trees, preferably in heavily timbered bottom lands or swampy woods; open deciduous or mixed coniferous woodlands with very large trees [including pecan groves]; heavy woods of oak and elm along rivers and creek bottoms; shade trees and dead trees in town" (G. F. Simmons, 1925:133).

The marked difference between the species in habitat occurrence functions in the overlap zone to limit contact and, at the same time, competition between them. It should be emphasized that these ecologic differences are shown elsewhere than in the zone of overlap. There is no conspicuous narrowing of habitat range in the Austin region. The overlap in habitat occurrence is sufficiently extensive, however, to warrant the hypothesis that either species would, in the absence of the other, occur in greater density in the overlap zone. Considering the fact that populations of *aurifrons* have managed to adapt to mesic and humid habitats in México, it is perhaps surprising that the distribution of the Texas population stops abruptly in the Austin region, unless, of course, the presence of *carolinus* prevents further extension of range.

Behavioral Differences.—The two woodpeckers are much alike in behavior, as far as we have determined. *C. aurifrons* is warier than *C. carolinus* and therefore less easily approached and observed; it is decidedly more shy in the vicinity of its nest. Foraging habits seem to be identical in the two species. In the Austin region their breeding seasons coincide (G. F. Simmons, 1925).

The vocalizations are described by G. F. Simmons (*op. cit.*). Both species have the same repertoire of calls, but those of *aurifrons* are louder and harsher, and on this account easily recognized. The pulsed "location" call, used primarily to "advertise" territory in the breeding season, and the common warning *cha* note of the two species are compared in Fig. 1; other calls are equally similar. The "location" call of *aurifrons* is less precisely tuned and slightly higher-pitched than that of *carolinus*, and it ends less abruptly.

Lack of Interbreeding.—Considering the ecologic and morphologic similarities of *C. carolinus* and *C. aurifrons*, it is indeed surprising that they do not at least occasionally interbreed. However, in the past two years we have carefully noted the composition of dozens of pairs, and, invariably, the members have been of the same species. Moreover, we have seen no individual evidencing mixed ancestry, although, of course, hybridization in these morphologically similar species might be difficult to detect. The possibility that the color and pattern differences are controlled by a unifactorial genetic mechanism has been considered. If this were the case, interbreeding could occur without intergradation of characters in the hybrids; but it seems unlikely that this same mechanism would control voice and behavioral differences as well. Some specimens of *aurifrons* have one or more red or orange feathers in the nape, but this does not necessarily indicate hybridization. The same character occurs in many (perhaps all) yellow-naped populations of *aurifrons* and is no more marked or frequent in specimens from Travis County than in those from western Texas and northern México.

To sum up, we have found no evidence of cross-pairing or hybridization between members of the two populations, but the nature of the reproductive iso-

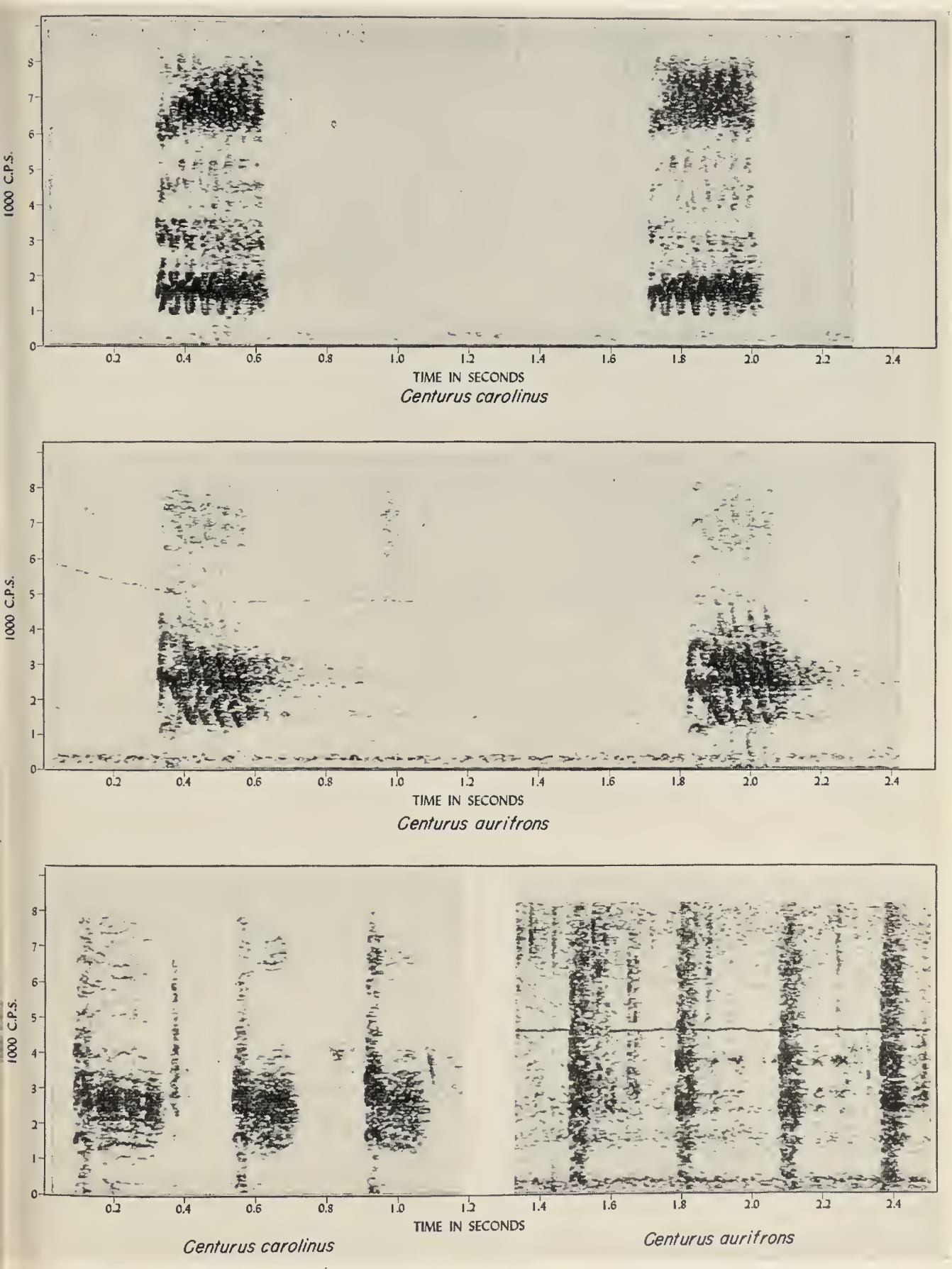

FIG. 1. Sound spectragraphs of calls af male **Centurus** woodpeckers fram central Texas. Above, "location" calls; belaw, warning calls. Intensity af markings is proportianal ta energy involved at the frequency level. (The thin line near 5000 c.p.s. in the graphs of **C. aurifrons** calls results from a signal in the tape recorder itself.)

lating mechanism remains to be determined. Differences in vocalizations seem hardly great enough to function alone as an effective isolating mechanism. At present practically no information concerning sexual behavior in these species, or, for that matter, in any other species of the genus, is available. A thorough study of courtship and mating behavior is indicated, but this might be a difficult undertaking. It appears that in both species many birds remain paired throughout the year. G. F. Simmons (1925:133) notes that *carolinus* "frequently spends the winter about trees where it will nest the following spring. . . ." It is possible that pair bonds are maintained for several years or for life. If so, opportunity to study the critical stage of pair formation will be limited.

It may be noted in passing that these facts bear on the problem of reproductive isolation, since the probability of the occurrence of a "mistake" in pairing, leading to hybridization, depends on the absolute number of pair bonds formed. In species in which pairing occurs each spring, opportunities for "mistakes" are obvously greater than in species in which a bird pairs only once or a few times in its life. Moreover, the formation of lasting pair bonds is usually preceded by long courtship or "engagement" periods, which also tend to reduce the chances for hybridization (Mayr, 1942).

Territorial Relations.—Observations by one of us (Selander) on the general spatial relations of the two species and of several interspecific conflicts in 1956 suggested that they held mutually exclusive territories. Subsequent observations confirmed this suspicion, and in the spring of 1957 the territorial relations of two pairs were studied in some detail.

The study area was at the Deep Eddy housing project of the University of Texas in western Austin (Fig. 2). Observations were made almost daily from March 25 to May 11, 1957, and occasionally thereafter through May, 1958. Movements of the woodpeckers were plotted on maps, and the records are summarized in Fig. 3.

The pair of *C. carolinus* nested in a chinaberry tree approximately 75 yards from a deciduous oak tree in which the pair of *C. aurifrons* nested. Both nests were about 15 feet above the ground. The territories of both species extended well beyond the limits of the area shown in Fig. 3.

As observations of movements accumulated, it soon became apparent that a rigid, sharply defined line of division was maintained between territories of the two species. No tree in the study area was frequented at the same time by both species without conflict. Even in the absence of their neighbors, the pairs were reluctant to cross the territorial boundary.

The territorial boundary was well established when our study began, and conflicts were infrequently seen. On March 28, the male *aurifrons* penetrated the *carolinus* territory to point "A" in Fig. 3; immediately he was attacked by the male *carolinus* and driven back to his territory. Again, on April 6, the male *aurifrons* entered the other species' territory.

FIG. 2. Above: View of territory of *C. carolinus* at Deep Eddy study area, taken facing north from position "A" in Fig. 3. Below: Study area at Walker Ranch. Nest-tree of *M. erythrocephalus* is just left of large mesquite; that of *C. carolinus* is on the far right.

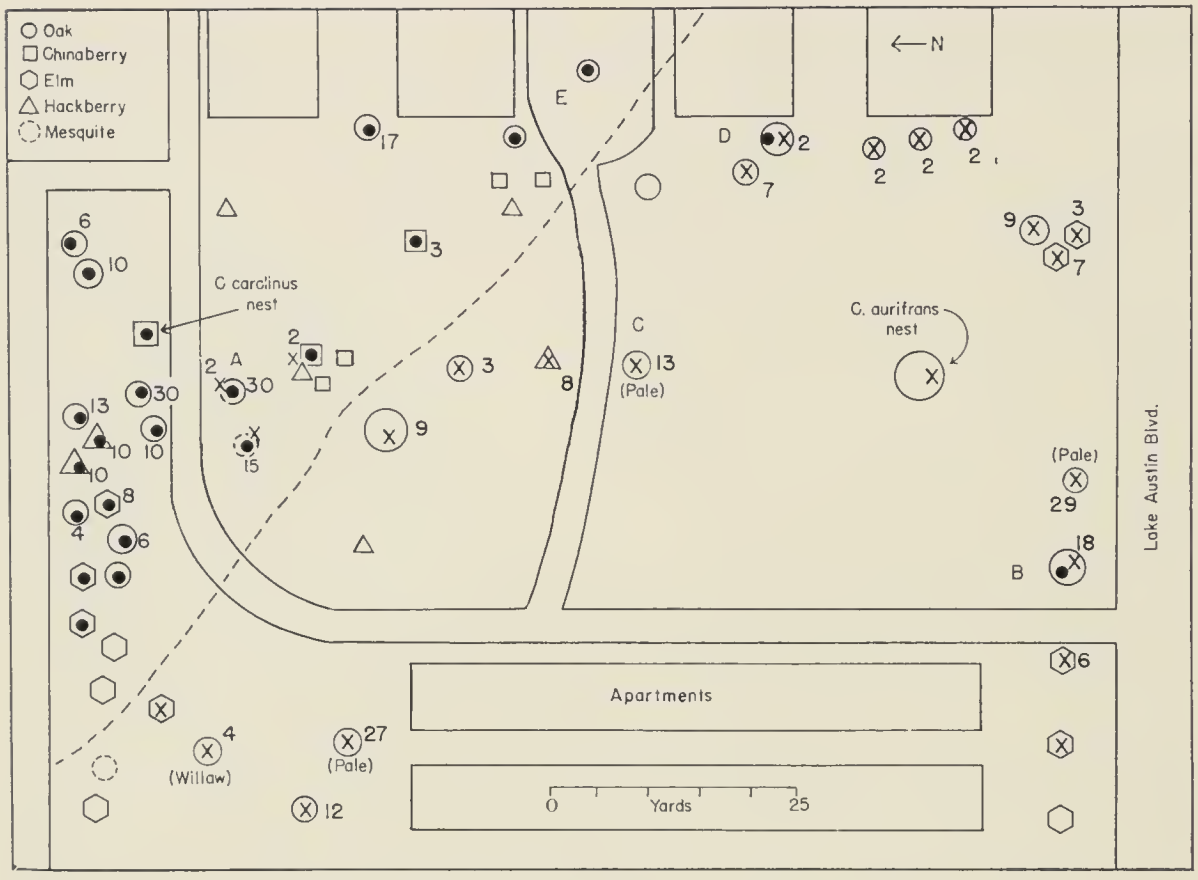

FIG. 3. Study area at Deep Eddy housing project, Austin, showing interspecific territorialism in *Centurus*. X's indicate records of *C. aurifrons*; dots represent records of *C. carolinus*; where there is more than one record for a location, the number is indicated. The territorial boundary is indicated by the dashed line.

The two males fought in three different trees near point "A," and the *aurifrons* finally retreated to his territory, flying to the nest-tree.

On April 25, the female *aurifrons* entered *carolinus* territory. This time the female *carolinus* responded, a fight ensued, and the female *carolinus* chased the female *aurifrons* back across the territorial boundary.

C. carolinus less frequently trespassed on *C. aurifrons* territory. On May 11, however, the male *carolinus* flew very near to the ground from his nest-tree to the tree at position "B." It "hid" behind the tree for two minutes, peeked around one side or the other at the nest-tree of *aurifrons*, then flew toward the *aurifrons* nest-tree, where the male and female were perched. Both the male and female *aurifrons* attacked the male *carolinus* as he flew toward the tree. The female soon returned to the nest-tree, but the male continued to attack, driving the male *carolinus* to position "C," at which point he circled back and returned to the nest-tree. The retreating male *carolinus* continued on to his own nest-tree.

On March 29, the male *carolinus* entered *aurifrons* territory, where he fought with another male *carolinus* at position "D," and again within his own territory at position "E." The latter individual held a territory east of the study area. The pair of *aurifrons* was foraging off the study area at the time of this invasion.

Displays and calls used in interspecific territorial defense did not differ in any way from those employed in intraspecific encounters of the same type.

In the spring of 1958, the territory of the pair of *aurifrons* at Deep Eddy was

expanded to include that part of the territory of *carolinus* shown in Fig. 3. On April 19, the two males engaged in a vigorous fight in the *carolinus* nest-tree, following which *carolinus* retreated from the area. Subsequently, the pair of *aurifrons* raised a brood in the same hole used by *carolinus* in the previous year.

Relations of *C. carolinus* and *M. erythrocephalus*

In April, 1958, an unexpected opportunity to study ecologic relations of *C. carolinus* and a third species of similar size (Table 1), *Melanerpes erythrocephalus*, was provided. This woodpecker, like *C. carolinus*, with which it is sympatric in southeastern Canada and the eastern United States, reaches its southwestern distributional limit in central Texas at Austin. Formerly a fairly common summer resident in the Austin region (G. F. Simmons, 1925:131), it is now rare. There have been no more than a half-dozen records of this species in Travis County in the last 10 years. It is possible that withdrawal of *M. erythrocephalus* from central Texas was related to the long drought that ended in the spring of 1957 (Blair, 1958). Now that environmental conditions are again "normal" in this region, it will be interesting to see if it returns in any numbers.

On April 17, we were directed by Mr. Wyle Hord to the territory of a pair of *erythrocephalus* on the Walker Ranch, along the Colorado River about two miles east of Austin (Fig. 4). According to Mr. Hord, the pair was first seen by him in the spring of 1957. The birds nested successfully in 1957 and wintered there in 1957–58. A fledgling was seen near the nest-hole on August 7 by Mr. Fred S. Webster and Dr. C. H. Brownlee. Webster, who has been one of the most active observers in the central Texas region for the past six years, informs us that this is the only breeding record of this woodpecker in the Austin region that has come to his attention. He suspects, however, that a few additional pairs may be found along the Colorado River between Austin and Bastrop. Occasionally, lone birds have been seen in winter along Onion Creek, a few miles southeast of Austin, and along the Colorado River.

Fortunately, a nesting pair of *carolinus* was located in the same area, permitting study of the territorial relations of the two species (Fig. 4). Observations were made at the Walker Ranch from April 17 to 23 and on May 1.

Activities of the *erythrocephalus* centered about a small, dead cottonwood tree adjacent to a small corral and a mesquite tree in a grassy meadow (Fig. 2). Several holes had been drilled in the cottonwood, including one "active" hole about 15 feet above the ground which the birds occasionally entered and in which at least one roosted at night. They were not incubating at the time of our study, but we saw some courtship behavior and it was obvious that they were preparing to breed; copulation was noted on May 1. On the same day a third individual of *erythrocephalus* appeared and was attacked and driven from the territory by the pair. Apparently this species breeds somewhat later, on the average, than does *C. carolinus* (Bent, 1939).

Movements of the birds were recorded and mapped (Fig. 4) over a period of about eight hours on three different days. The birds often visited the nest-tree and also spent a good deal of time in the adjacent grove of tall cottonwoods, to which they almost invariably retreated as we approached the nest-tree. They also visited cottonwoods and hackberry trees along the river; and on April 18 the pair fed for one-half hour in a large cottonwood

only 25 yards from the nest of *carolinus*. The pair of the latter species nested in a dead limb of a cottonwood which was larger than that used by *erythrocephalus*. The nest-hole was 15 feet above the ground, and the opening faced north. The nests of the two species were 80 yards apart.

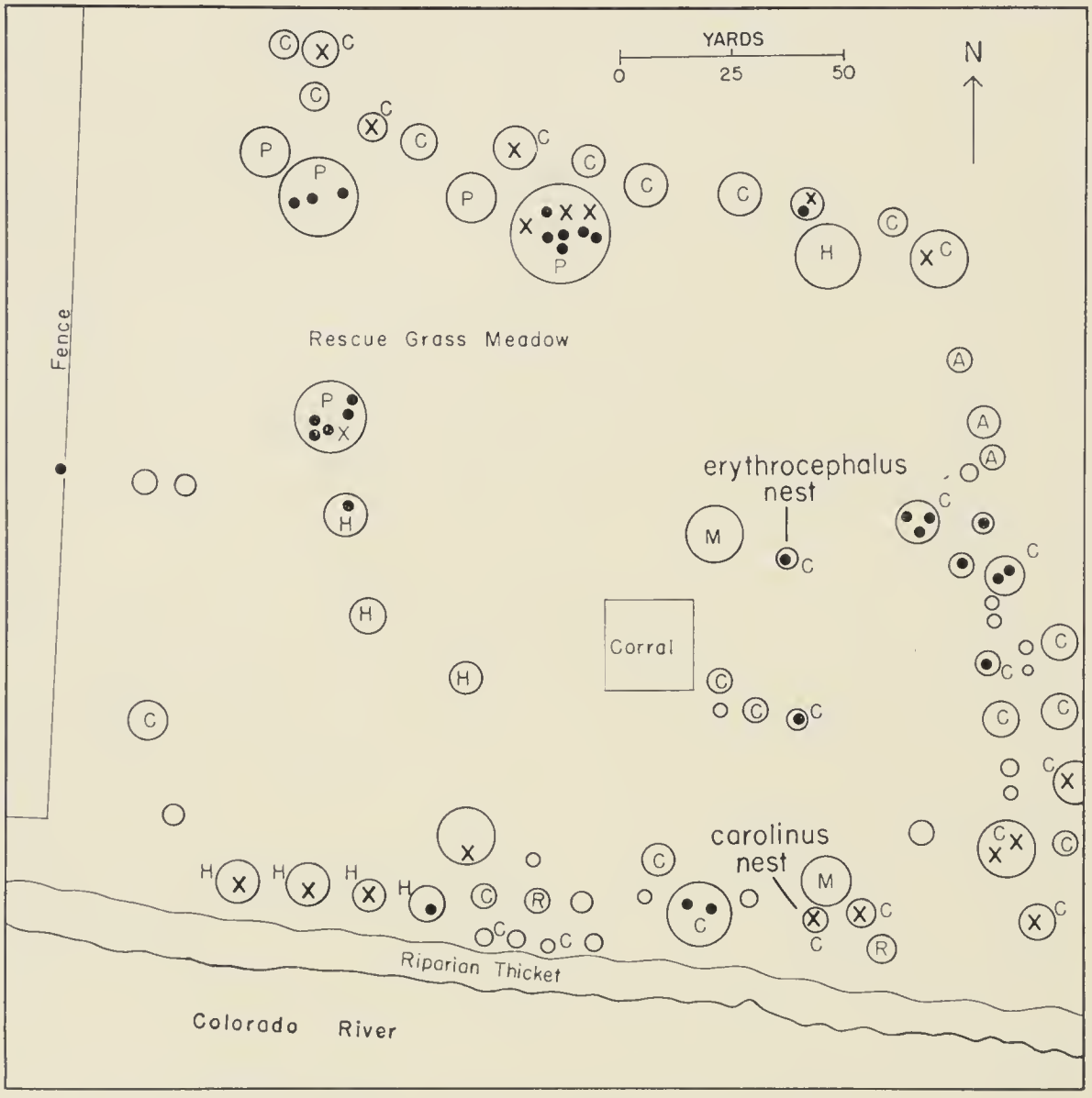

FIG. 4. Study area at Walker Ranch, showing overlap in territories of *C. carolinus* and *M. erythrocephalus*. X's indicate records of *carolinus*; dots represent records of *erythrocephalus*. Letters identify trees, as follows: A, ash; C, cottonwood; H, hackberry; M, mesquite; P, pecan; R, retama.

The pair members of *carolinus* were feeding young, making repeated visits to the nest with insects. They foraged over a much larger area than did the *erythrocephalus*. It will be seen in Fig. 4 that *carolinus* visited the large pecan tree to the north of the *erythrocephalus* nest-tree and also the southern part of the grove of cottonwoods and a line of hackberry trees along the river. Sometimes they flew south across the river to forage in trees located several hundred yards from their nest. On three occasions the male *carolinus* passed within a few feet of the nest-tree of the other species, while one or both of the latter were present,

but no interspecific conflict was seen. We noted, however, that *carolinus* did not forage in the grove of cottonwoods east of the *erythrocephalus* nest-tree, although several times they flew through the grove on their way to forage in trees beyond the study area to the north.

In summary, it seemed evident even from our limited series of observations that the territorial relations of *C. carolinus* and *M. erythrocephalus* were decidedly different from those of the former species and *C. aurifrons*. Their territories overlapped broadly and no interspecific conflict was noted.

Experiments with Dummies.—In an attempt to investigate factors involved in species recognition, we have performed a series of experiments in which dummy woodpeckers (study skins) were placed at various points in the territories of pairs of woodpeckers and the ensuing responses recorded. Not all of these throw light on the problem of interspecific territorialism, but they are none the less of some interest.

On May 8, 1957, a male dummy *C. aurifrons* was wired to a limb one foot below the nest-hole of the pair of *C. carolinus* that was being studied at Deep Eddy. Immediately the female *carolinus* attacked the dummy, striking it repeatedly with her bill for a period of 45 minutes. The great majority of her blows were directed at the head, particularly the eye region. Her attack stopped only when we approached the tree to retrieve the dummy, which was by then all but torn to pieces. The male made only a few passes at the dummy and left the tree a few minutes after it was placed in position.

The next day, May 9, we attached both male and female dummies of *carolinus* to the nest-tree of the pair of *aurifrons*, placing them within two or three feet of the nest-hole. At once both male and female *aurifrons* attacked the dummies, with the first blows being directed male to male and female to female. In this particular case, the male was much more aggressive than the female. The latter seemed apprehensive and alternately pecked at the dummy and retreated. After 15 minutes the head of the male dummy was detached and fell to the ground. Nonetheless, the male continued his attack on the headless dummy for another five minutes and then directed his response toward the female dummy; but he continued to make occasional passes at the headless dummy. Again the majority of blows were directed at the dummies' heads.

Ten minutes after the head was knocked from the male dummy, both dummies were removed from the nest-tree and placed on a telephone pole 40 yards from the nest-tree. The dummies were attacked in their new positions, but with lessened intensity, and the attacks were not so long sustained. The same type of experiment was performed by placing a dummy male *aurifrons* on a post within the territory of the *carolinus*. As in the previous experiment, the dummy was attacked with less intensity than when it was placed on the nest-tree.

The results of our work with dummies were not unexpected in view of our previous observations on territorial behavior. Subsequent tests with other pairs of *carolinus* have shown that the female of this species takes a more active part in defense of the nest-hole area against the dummies than does the male. The same pattern of behavior may be seen when one approaches the nest-tree of a pair of *carolinus* in which eggs or young are present. The female usually remains in the nest-tree calling excitedly, whereas the male almost invariably flies to a distant tree, returning only when the intruder has departed.

A second test with *aurifrons* also confirmed our first, to the effect that in this species the male is more aggressive in encounters at the nest-hole than is the female; but additional testing is needed.

The fact that attacks were usually directed at the heads of the dummies suggested that this part of the body alone supplies at least the important sign stimuli releasing aggressive behavior. This was confirmed by wiring the head of a dummy female *carolinus* two feet above the nest-hole of a pair of *carolinus* in a mesquite tree on the University of Texas campus on April 6, 1958. The female came to the nest-tree, suddenly flew to an adjacent stand of cottonwoods, and returned in company with the male. The male flew to the head and pecked it violently (Fig. 5), and the female soon joined him in the attack. After about 10 minutes, the forepart of the dummy's head, including the bill, came loose, and the male flew off with it in his bill. To our surprise, the female continued her attack on the remnants of the head, a ball of cotton used to stuff the dummy and a tuft of red feathers on the coronal and occipital regions. Her attack continued for several minutes but ceased abruptly when her blows dislodged the few remaining feathers. Shortly thereafter, the male returned and investigated the "remains"; then he entered the nest-hole, presumably to incubate, and the female foraged in the nest-tree. These observations suggest that the red feathers of the head are of paramount importance in releasing aggressive behavior. We have not pursued the problem further, but it is clear that the response to the head alone is fully as strong as to the entire dummy.

Despite the fact that the pair of *M. erythrocephalus* did not behave aggressively toward *C. carolinus*, even when the male of the latter species flew within a few feet of their nest-tree, they readily attacked dummies of that species placed near their nest-hole (Fig. 6). When presented simultaneously with dummies of *carolinus* and their own species, they usually directed their initial attack at the latter, but the defense of the nest-tree against the *carolinus* dummy was vigorous. These tests help account for the fact that the pair of *carolinus* avoided perching in the vicinity of the nest-tree of *erythrocephalus*.

Discussion

In a recent review of interspecific territorialism in birds, K. E. L. Simmons (1951:407) has suggested that the term be confined to cases in which "a territory holder of one species exhibits persistent aggressive behaviour to an intruding bird of a second species, showing to it some, if not all, of the reactions usually forthcoming in intraspecific encounters." Further, he suggests that the aggression should be related to the territory as a whole and not merely to a particular part of it, thus excluding contests between hole-nesters at nest-sites. We are in general agreement with Simmons in this regard. Conflicts between hole-nesting species competing for roosting or nesting sites frequently involve

FIG. 5. Male *C. carolinus* attacking head of male dummy *C. carolinus* near nest-hole.

species which do not hold exclusive territories. The relations of *C. aurifrons* and *C. carolinus,* however, satisfy all criteria for interspecific territorialism. The case is unusual in that the territories are mutually exclusive; in their ter-

ritorial relations, the two woodpeckers behave as if they were a single-species population.

Where the two species of *Centurus* occur together, competition for space and nesting sites is manifested in interspecific territorialism. Lack of significant differences in feeding and nesting habits and in timing of events of the annual cycle would seem to preclude the possibility of their coexistence, except in a narrow contact zone where there is complex inter-digitation of vegetation types. Reproductive isolation is complete, but the species have so far failed to evolve ecologic adjustments that would permit extensive sympatry.

In the case of *Centurus carolinus* and *Melanerpes erythrocephalus*, sympatry is possible because the necessary ecologic adjustments have been made, and it appears that they do not show interspecific territorialism. There are obvious differences between these species in foraging habits and habitat occurrence. Our observations show that *erythrocephalus* feeds regularly not in the manner of "typical" woodpeckers but by "flycatching." The relatively longer wing and tail of this species (Table 1) may be related to this trait, which has also been noted by several other writers, including G. F. Simmons (1925:132), Skinner (*fide* Bent, 1939:201), and Nauman (1930). Studies of stomach contents by Beal (1911) reflect differences in foraging habits in the two woodpeckers. He notes that *erythrocephalus* "eats very few beetle larvae or other grubs, or ants that live in wood or other places of concealment. Apparently it is not so fond of pecking wood as are the other species [of woodpeckers] . . . ." In our experience, *carolinus* "flycatches" only occasionally, and all lines of evidence point to the conclusion that *erythrocephalus* obtains significantly less of its food by foraging over trunks, branches, and leaves than does the other species. In the course of our studies in April, we rarely saw *erythrocephalus* dig or probe into bark, whereas *carolinus* fed almost exclusively in this fashion. Typically, *erythrocephalus* fed by perching in exposed positions atop large pecan or cottonwood trees and darting out some 20 to 40 yards to catch large flying insects, some of which were beetles. We watched one or both individuals repeat this action for periods of up to an hour, and Nauman (1930) calculated that one bird, which was feeding a fledgling, made five to seven sallies per minute, catching a calculated 600 flying insects in the course of an hour. Between sallies, the birds often perch crosswise in the manner of passerines, and the head is turned from side to side as they peer about for insects. Some insects are swallowed immediately after a bird returns to its "lookout" perch, but larger ones are usually wedged in crevices (typically in stumps), smashed, and picked apart.

This discussion is not intended to suggest that *erythrocephalus* feeds exclusively in this manner. The species also drills into wood and, especially in the fall and winter, feeds on beechnuts, berries, acorns, seeds, and other vege-

FIG. 6. *M. erythrocephalus* attacking male dummies of its own species (above) and *C. carolinus* (below).

table food (Beal, 1911); in addition, it reportedly (Bent, 1939:199) takes both eggs and young of some small passerines.

The fact that *erythrocephalus* tends to frequent more open situations than does *carolinus* may be related to differences in feeding habits. In any event, it is probably important in permitting the two species to coexist. Bent (1939: 195) regarded *erythrocephalus* as "essentially a bird of open country and not in any sense a forest dweller," and other naturalists quoted by Bent have noted its preference for open groves, "old burns," and other similar situations. Our observations and those of G. F. Simmons (1925:131) in Texas agree fully with these reports. Simmons noted the preference of *erythrocephalus* for edges of woodlands, orchards, groves, and clearings in open woods, and that of *carolinus* for heavily wooded bottomlands. At the Engeling Wildlife Management Area, Anderson County, Texas, in November, 1956, we found *erythrocephalus* somewhat less numerous than *carolinus* and confined to a partly burned stand of trees bordering a meadow, whereas *carolinus* was generally distributed throughout the oak forest. Even in the study area at Walker Ranch, a preference of *erythrocephalus* for open situations was apparent, as evidenced, for example, by the location of the nests of the two species (see Fig. 4).

Since the foregoing was written, Kilham (1958a, 1958b, and 1958c) has published three important articles dealing with the biology of *C. carolinus* and *M. erythrocephalus* in Maryland. Among his significant findings are the following: Pairs of *C. carolinus* disband in late summer, and nesting, which begins in April, is preceded by a long period of courtship and pair bond reinforcement beginning in January. Individuals of *M. erythrocephalus* holding small winter territories in woodland defended their areas and acorn stores against *C. carolinus* and a variety of other species of birds.

Summary

Interspecific relations of three woodpeckers of approximately equal size were studied in central Texas. The closely related, morphologically similar Red-bellied Woodpecker (*Centurus carolinus*) and Golden-fronted Woodpecker (*Centurus aurifrons*) are sympatric in a narrow zone in the Austin region. Within this overlap zone, differences in habitat occurrence limit contact and competition; but both species occur in the city of Austin, where they hold mutually exclusive territories. Feeding and nesting habits are similar in the two species, as are vocalizations and displays. Reproductive isolating mechanisms, the nature of which are unknown, have evolved, but the species have not made ecologic adjustments which would permit extensive sympatry.

The territorial relations of a pair of *C. carolinus* and a pair of Red-headed Woodpeckers (*Melanerpes erythrocephalus*) were studied. Their territories overlapped broadly, and interspecific antagonism was not observed. It is suggested that differences in foraging habits and habitat occurrence are important factors permitting extensive sympatry of these species.

The reactions of nesting woodpeckers to dummies were tested. Both *carolinus* and *aurifrons* attacked dummies of their own or of other species placed in their nest-trees or elsewhere in their territories. The head of a *carolinus* dummy was as effective in releasing aggressive behavior in *carolinus* as was the entire dummy. Dummies of *carolinus* and *erythrocephalus* placed near the nest-hole of *erythrocephalus* were attacked with approximately equal vigor.

Literature Cited

Attwater, H. P.

1892 List of birds observed in the vicinity of San Antonio, Bexar County, Texas. *Auk*, 9:229–238, 337–345.

A. O. U. Check-list Committee

1957 Check-list of North American birds (5th ed.). American Ornithologists' Union, Baltimore, 691 pp.

Beal, F. E. L.

1911 Food of the woodpeckers of the United States. *U. S. Dept. Agric., Biol. Surv. Bull.*, 37: 64 pp.

Bent, A. C.

1939 Life histories of North American woodpeckers. *U. S. Nat. Mus. Bull.*, 174: 334 pp.

Blair, W. F.

1950 The biotic provinces of Texas. *Texas Journ. Sci.*, 2:93–117.

1958 Changes in vertebrate populations under conditions of drought. *Cold Spring Harbor Symp. Quant. Biol.*, 22:273–275.

Brodkorb, P.

1957 Birds. Pp. 361–613 *in* Blair, W. F., *et al.*, Vertebrates of the United States. McGraw-Hill Book Co., Inc., New York.

Burleigh, T. D., and G. H. Lowery, Jr.

1944 Geographical variation in the Red-bellied Woodpecker in the southeastern United States. *Occas. Papers Mus. Zool., Louisiana State Univ.*, no. 17:293–301.

Dixon, K. L.

1950 Notes on the ecological distribution of Plain and Bridled Titmice in Arizona. *Condor*, 52:140–141.

1954 Some ecological relations of chickadees and titmice in central California. *Condor*, 56:113–124.

1955 An ecological analysis of the interbreeding of crested titmice in Texas. *Univ. Calif. Publ. Zool.*, 54:125–206.

Kilham, L.

1958a Pair formation, mutual tapping and nest hole selection of Red-bellied Woodpeckers. *Auk*, 75:318–329.

1958b Sealed-in winter stores of Red-headed Woodpeckers. *Wilson Bull.*, 70:107–113.

1958c Territorial behavior of wintering Red-headed Woodpeckers. *Wilson Bull.*, 70: 347–358.

Koelz, W. N.

1954 Ornithological studies. II. A new subspecies of Red-bellied Woodpecker from Texas. *Contr. Inst. Reg. Expl.*, 1:32.

Legg, K., and F. A. Pitelka

1956 Ecologic overlap of Allen and Anna Hummingbirds nesting at Santa Cruz, California. *Condor*, 58:393–405.

Mayr, E.
1942 Systematics and the origin of species. Columbia Univ. Press, New York, 334 pp.
Nauman, E. D.
1930 The Red-headed Woodpecker. *Bird-Lore*, 32:128–129.
Pitelka, F. A.
1951 Ecologic overlap and interspecific strife in breeding populations of Anna and Allen Hummingbirds. *Ecology*, 32:641–661.
Simmons, G. F.
1925 Birds of the Austin region. Univ. Texas Press, Austin, 387 pp.
Simmons, K. E. L.
1951 Interspecific territorialism. *Ibis*, 92:407–413.
Wetmore, A.
1948 The Golden-fronted Woodpeckers of Texas and northern Mexico. *Wilson Bull.*, 60:185–186.

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THE UTILIZED TERRITORY OF THE OVENBIRD

BY JUDITH STENGER AND J. BRUCE FALLS

HANN (1937) showed that the Ovenbird (*Seiurus aurocapillus*) strongly exhibits territorial behavior. Since the area defended by the male is used for mating, nesting, and as a feeding ground for adults and young, it exemplifies type A of Nice's (1941) classification.

We studied territories of Ovenbirds in four forest types at the Wildlife Research Station of the Ontario Department of Lands and Forests, in Algonquin Park, Ontario. Observations were carried out during the summers of 1955 and 1956. This paper deals with the extent of the area utilized by a male Ovenbird during the breeding season, some aspects of the way in which it is utilized, and the variations in size which occur in this area as the breeding season progresses.

Description of Study Areas

Five plots for the study of territories of Ovenbirds were established in four forest types as follows: one plot in aspen, one in a conifer–birch association, two in a mixed hardwood–conifer association, and one in mature maple forest. One of the mixed plots was used only in 1955, and was so similar to the other that it will not be described in detail. The conifer–birch plot was used only in 1956. Each plot was surveyed into a grid of 66-foot squares and the intersections were marked. Areas of plots used varied from eight to 20 acres.

Differences in tree species and differences in number, height, and density of canopy layers were used to map study plots into cover types by inspection. Within each cover type circular areas of 33-foot radius were chosen arbitrarily. These samples, which included from eight to 16 per cent of the area in each plot, were used to estimate height, density (percentage of sky obstructed by foliage, not allowing for spaces between leaves), and species composition of each stratum of the forest. In addition, species and diameter at breast height (DBH) of all trees more than 1.5 inches in diameter were recorded.

Millacre quadrats (6.6 feet square) located at the grid intersections were used to estimate percentage of ground covered by logs and rocks, and by each species in the low vegetation.

Brief descriptions of the four main study plots are given below. The percentage of trees in the canopy made up by each of the commoner species is included.

Aspen Plot.—Upper canopy 93 per cent aspen (*Populus tremuloides, P. grandidentata*). Lower canopy 37 per cent maple (mainly *Acer rubrum*), 28 per cent white spruce (*Picea glauca*), and 23 per cent balsam fir (*Abies balsamea*). Brush layer denser than in other plots and composed mainly of hazel (*Corylus cornuta*) and small conifers. Common ground plants—bunchberry (*Cornus canadensis*), bracken (*Pteridium aquilinum*), and sarsaparilla (*Aralia nudicaulis*). Leaf litter mainly of broad leaves.

Conifer–birch Plot.—Upper canopy 39 per cent white birch (*Betula papyrifera*), 20 per cent aspen, and 32 per cent white pine (*Pinus strobus*). Lower canopy 71 per cent balsam fir. Brush of hazel and small conifers. Common ground plants—bracken, bunchberry, sarsaparilla, blueberry (*Vaccinium angustifolium, V. myrtilloides*), and grasses. Leaf litter mainly of pine needles.

Mixed Plot.—Variable. Parts resemble all other plots. Large areas of mature hardwood and other areas of pure conifer. Upper canopy 37 per cent white birch, 23 per cent red and sugar maples (*Acer rubrum, A. saccharum*), and 13 per cent white spruce. A few large specimens of yellow birch (*Betula lutea*), white pine, and hemlock (*Tsuga canadensis*). Lower canopy, present in only 34 of 42 samples, mainly of balsam fir (36 per cent), maples (20 per cent), white spruce (19 per cent), and white birch (12 per cent). Brush layer, present in only half the samples, chiefly of hazel, striped maple (*Acer pensylvanicum*), and small conifers. Common ground plants—bunchberry, bracken, sarsaparilla, maple seedlings, dewberry (*Rubus pubescens*), and grasses.

Maple Plot.—Most complex canopy of any plot, having three layers all dominated by sugar maple, 85 per cent in upper and lower canopy, and 91 per cent of understory. Beech (*Fagus grandifolia*), 12 per cent of upper canopy. Some ironwood (*Ostrya virginiana*) in all three canopy layers. Lower canopy and understory present in 10 and 12 out of 17 samples, respectively. Brush present in only three of 17 samples, chiefly of striped and sugar maples. Ground vegetation mainly of tree seedlings—sugar maple, striped maple, and beech. More logs and deeper leaf litter than in other plots.

Table 1 shows the height and density of each stratum of the forest in each of these plots. Table 2 shows the composition of the forest. Trees are classified with regard to tolerance (here taken to mean capacity to develop and grow in the shade of and in competition with other trees) following Toumey and Korstian (1947).

When study plots are arranged in the order—Aspen, Conifer–birch, Mixed,

TABLE 1

HEIGHT AND DENSITY OF EACH STRATUM OF FOREST IN STUDY PLOTS

Strata	Plots			
	Aspen	Conifer–birch	Mixed	Maple
Height (feet)[1]				
Upper canopy	45	50	55	85
Lower canopy	25	25	25	35
Understory	—	—	—	17
Brush	8	5	6	4
Ground vegetation	1.5	1.5	1.5	1
Density (per cent covered)[1]				
Upper canopy	50	45	65	75
Lower canopy	20	15	20	85
Understory	—	—	—	40
Brush	50	30	25	25
Ground vegetation	70	70	45	5
Logs and rocks	5	5	10	10

[1] Median values are used for height and density.

TABLE 2

COMPOSITION OF FOREST IN STUDY PLOTS

Species[1]	Trees[2] per acre				Saplings[3] per acre			
	Aspen	Conifer–birch	Mixed	Maple	Aspen	Conifer–birch	Mixed	Maple
Tolerant								
Sugar and red maple	70	0	46	182	71	0	10	83
Striped maple	0	0	2	5	0	0	7	6
Ironwood	3	0	3	13	0	0	1	17
Beech	0	0	0	19	0	0	0	1
Balsam fir	53	141	58	0	39	79	21	0
Spruce (mainly white)	69	28	43	0	37	8	6	0
Hemlock	0	0	9	5	0	0	0	0
Intermediate								
Yellow birch	0	0	10	0	0	0	0	0
Pine (mainly white)	1	66	20	0	0	2	1	0
Intolerant								
Aspen (mainly trembling)	378	40	2	0	25	0	0	0
White birch	10	80	64	0	9	2	2	0
Willow sp.	0	0	0	0	7	0	0	0
Totals	584	355	257	224	188	91	48	107
Per cent composition								
Tolerant	33	47	62	100	78	96	94	100
Intermediate	0	19	12	0	0	2	2	0
Intolerant	67	34	26	0	22	2	4	0

[1] Three species that had fewer than five stems per acre in any plot are omitted.
[2] Trees have DBH over 2½ inches.
[3] Saplings have DBH 1½ to 2½ inches.

Maple, a number of trends are apparent. Height and density of the upper canopy increase while density of brush and ground cover decreases from Aspen to Maple (Table 1). Number of trees per acre and the proportion of trees made up by intolerant species decrease (Table 2). On the other hand, the proportion of trees belonging to tolerant species increases. A high proportion of saplings is tolerant in all plots.

These trends suggest that the plots represent an early stage (Aspen), two intermediate stages (Conifer–birch, Mixed), and a late stage (Maple) in forest development. However, they probably do not represent stages in a single succession. The Aspen and Conifer–birch Plots seem likely to become more coniferous. These stands may be regarded as local representatives of the boreal forest. The Mixed and Maple Plots will likely continue to support mixed or hardwood stands. This is not surprising since Algonquin Park lies in a transition zone between the boreal forest and the northern conifer–hard-

wood forest (as described by Brown and Curtis, 1952), and stands of both types are found on different sites within the area (Halliday, 1937).

Method Used to Study Territory

Territorial disputes between male Ovenbirds were observed from the time the birds arrived on the breeding grounds until after the young had left the nest. Most encounters consisted of chasing and vocalizing (call notes and songs) or only vocalizing, although physical contact was occasionally observed. Disputes were fewer, shorter, and less vigorous as the breeding season advanced. Not enough territorial disputes were observed to outline the area defended by any individual, i.e., to measure territory in the strict sense.

Instead, all locations where a male was observed were plotted and used to estimate the area utilized by that bird. Many of these locations were estimated when a bird was heard singing.

Occurrence of song distinguished males from females which are similar in plumage but do not sing. A few birds were marked with colored bands, but individual males were identified chiefly by differences in their songs. Tape recordings were useful for verifying identifications. Detailed analyses of songs will be published elsewhere.

Nine males were studied in 1955, and 13 in 1956. One observer watched a bird, taking care not to disturb it. When the bird was located, its position was marked on a map, and the height at which it was observed was recorded. Locations on the map were numbered consecutively. Each bird was studied one day a week, which amounted to eight or nine times during the breeding season in 1956. Fewer observation periods were completed in 1955. The observation period each day extended from 4:15 to 5:45 a.m. E.S.T. in 1955, and from 5:15 to 9:30 a.m. E.S.T. in 1956.

Total Territory Utilized During the Breeding Season

All locations where each male Ovenbird was observed from the arrival of its mate until its young left the nest were mapped as in Fig. 1. For each bird most of the points formed a compact group, but a few points (about five per cent) lay well outside this group. In order to determine the *total utilized territory*, the five per cent of points that were most isolated were rejected in all cases. Peripheral points of the remaining group were joined to form a polygon having no indentations (Fig. 1). Three of the birds (M 26, M 27, M 30) were not observed in certain open areas that lay within the polygons, and these areas were subtracted in finding the area of the total utilized territory. Areas were obtained from the maps using a compensating planimeter.

Points obtained during the premating period were excluded because there was sometimes a shift in the location of a territory when the female arrived. Points obtained after the young left the nest were excluded for two reasons. In the first place, the family group breaks up (Hann, 1937), and it is doubtful

whether most males still exhibit territorial behavior. Secondly, young birds were apparently not cognizant of the boundaries of the adult's territory and sometimes wandered beyond, in which case the male went beyond the boundary to feed them.

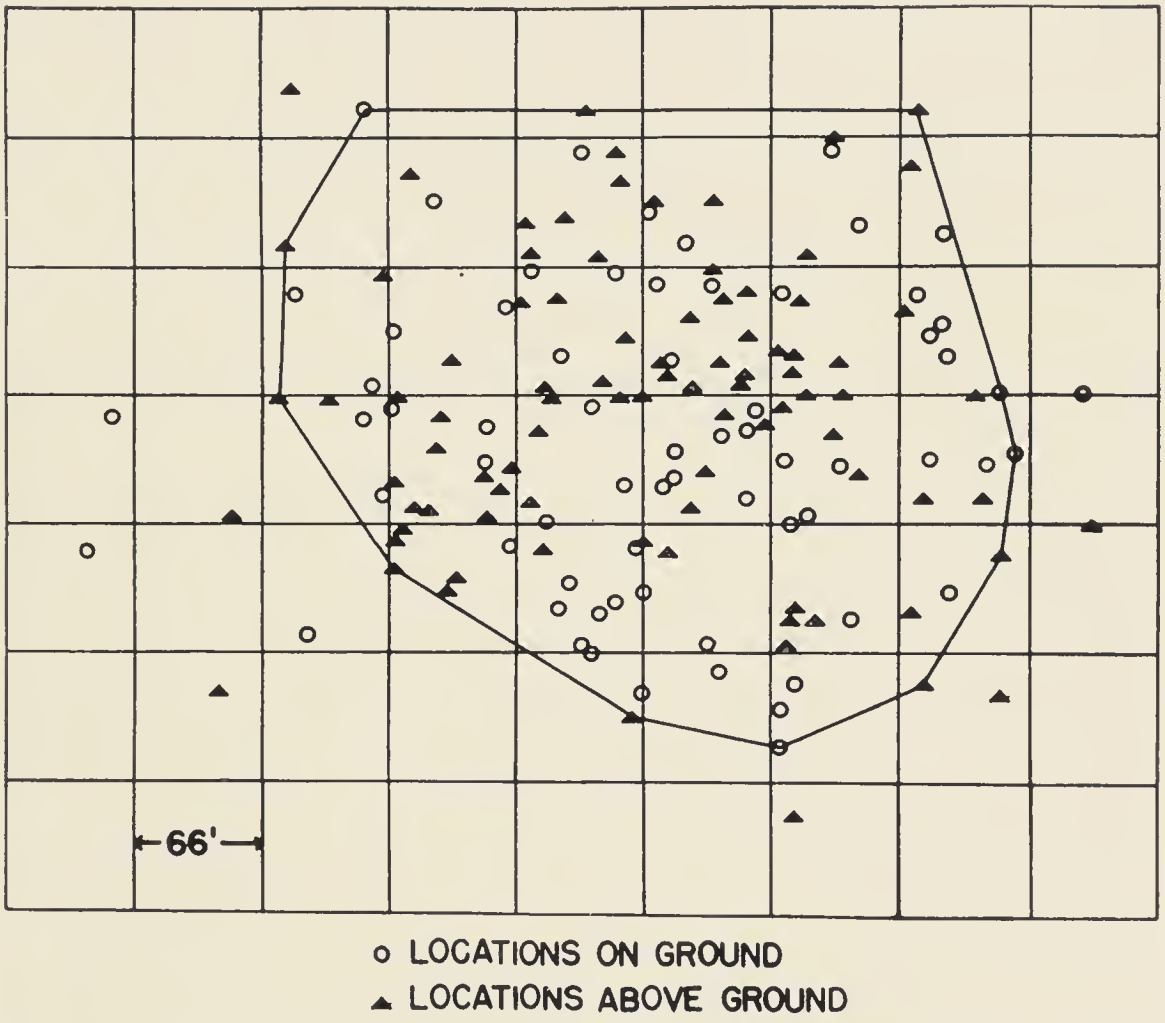

FIG. 1. Total utilized territory of M 20. Locations where the bird was observed are shown.

The *total utilized territory* as determined above is not necessarily identical with the area that a bird will defend if called upon to do so. However, it is an estimate of the area used during the breeding season by a male exhibiting territorial behavior. It is the segment of the environment in which most of the activities associated with the reproductive cycle are performed.

Distribution of activities.—Locations where male Ovenbirds were seen or heard did not appear to be concentrated anywhere but were scattered throughout the total utilized territory. Data for M 20 shown in Fig. 1 are typical in this regard. Most points represented locations where a bird sang in the trees but no particular song posts were used repeatedly. Prolonged vocalization occurred in any part of the territory where there were trees (usually deciduous)

of a suitable height (Fig. 1). The Ovenbird feeds almost entirely on the ground (Stenger. 1958), and nearly all observations of a bird on the ground represented feeding activity. When these observations are plotted separately (Fig. 1) they too are seen to be scattered throughout the territory.

Unforested areas that appeared to be similar to each other were used by some birds but not by others. Large open areas of bracken and grasses in the Aspen Plot were not used by M 26 and M 27, whereas M 23 and M 24 in the Conifer–birch Plot were observed to use similar areas. M 30 in the Maple Plot did not utilize an open wet area.

The total area utilized by a female was not determined. However, a female was sometimes observed in company with a male or was flushed from its nest and could then be followed. Females were not observed beyond the boundaries of their mates' territories. However, they did not appear to take an active part in defense of the territory. The nest was located within the total utilized territory although often near the edge.

Buffer zone.—When total utilized territories of neighboring birds are drawn on a map there is usually a *buffer zone* (Williamson, 1956) between them. An example is shown in Fig. 2 where all the territories except those of M 4 and M 5 were separated by approximately 60 feet. In the Maple Plot, where territories were largest, the buffer zone was about 100 feet wide.

Sometimes there appears to be considerable overlap between adjacent territories as illustrated in the Mixed Plot in 1956 (Fig. 3). This results from shifting of territories during the breeding season; territories utilized by adjacent birds on any one day were always well separated.

Most of the points rejected in the estimation of total utilized territory occurred in the buffer zone. When a bird was observed in the buffer zone it either did not sing at all or gave one or two weak songs. These observations suggest that Ovenbirds recognize the boundaries of their territories since they behave differently in the buffer zone than inside the total utilized territory.

Extent of the total utilized territory.—All the birds that were studied occupied fairly compact territories approximately circular or oval in shape (Figs. 1–3). The size of these areas varied considerably as shown in Table 3. The total utilized territories of M 5 and M 7 were smaller when they were unmated than when they were mated. When birds renested (this occurs only when the first attempt at nesting fails) they occupied larger territories in two cases (M 5, M 32) and a smaller territory in one case (M 28) than during the first attempt at nesting. They did not change location, however (Fig. 3).

The greatest differences in size of territory occurred among different forest types. Considering first nesting attempts in 1956, for the 11 birds for which comparable data are available (omitting M 7 and M 32), the average sizes of territories in the different plots are: Aspen 1.8 acres; Conifer–birch 2.2 acres; Mixed 2.4 acres; and Maple 3.3 acres. The same trend is shown in 1955

for the Aspen, Mixed, and Maple plots. It was pointed out in the section dealing with study areas that when the plots are placed in this order they show a number of trends in the structure and composition of the forest. Thus, territory size increases as canopy height and density increase, as brush and ground vegetation decrease, and as the forest changes from an early seral stage with many intolerant trees, to a late stage in development characterized by fewer but more tolerant trees. These trends are quite marked when the territories in different plots are compared, but do not hold in every case within plots. These features of the habitat may affect the behavior of the birds, or may determine differences in the supply of food available to Ovenbirds, or both. The relationship between available food and size of territory is considered in a separate paper (Stenger, 1958).

Height of the territory.—The space occupied by a bird is a volume rather than an area and has a measurable height. It can be argued that a more accurate account of territory might be attained by comparing volumes. This

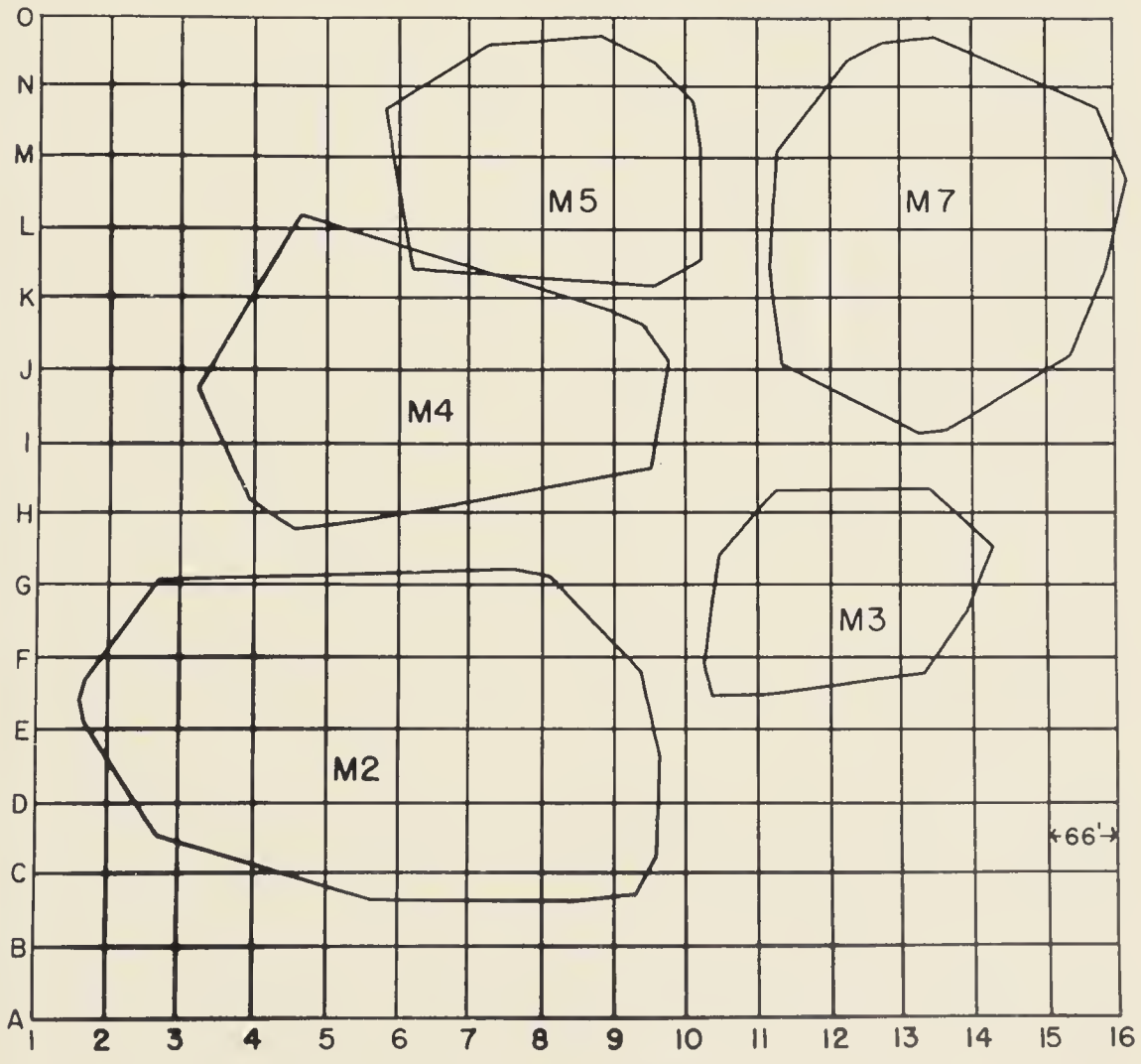

Fig. 2. Total utilized territories in Mixed Plot in 1955.

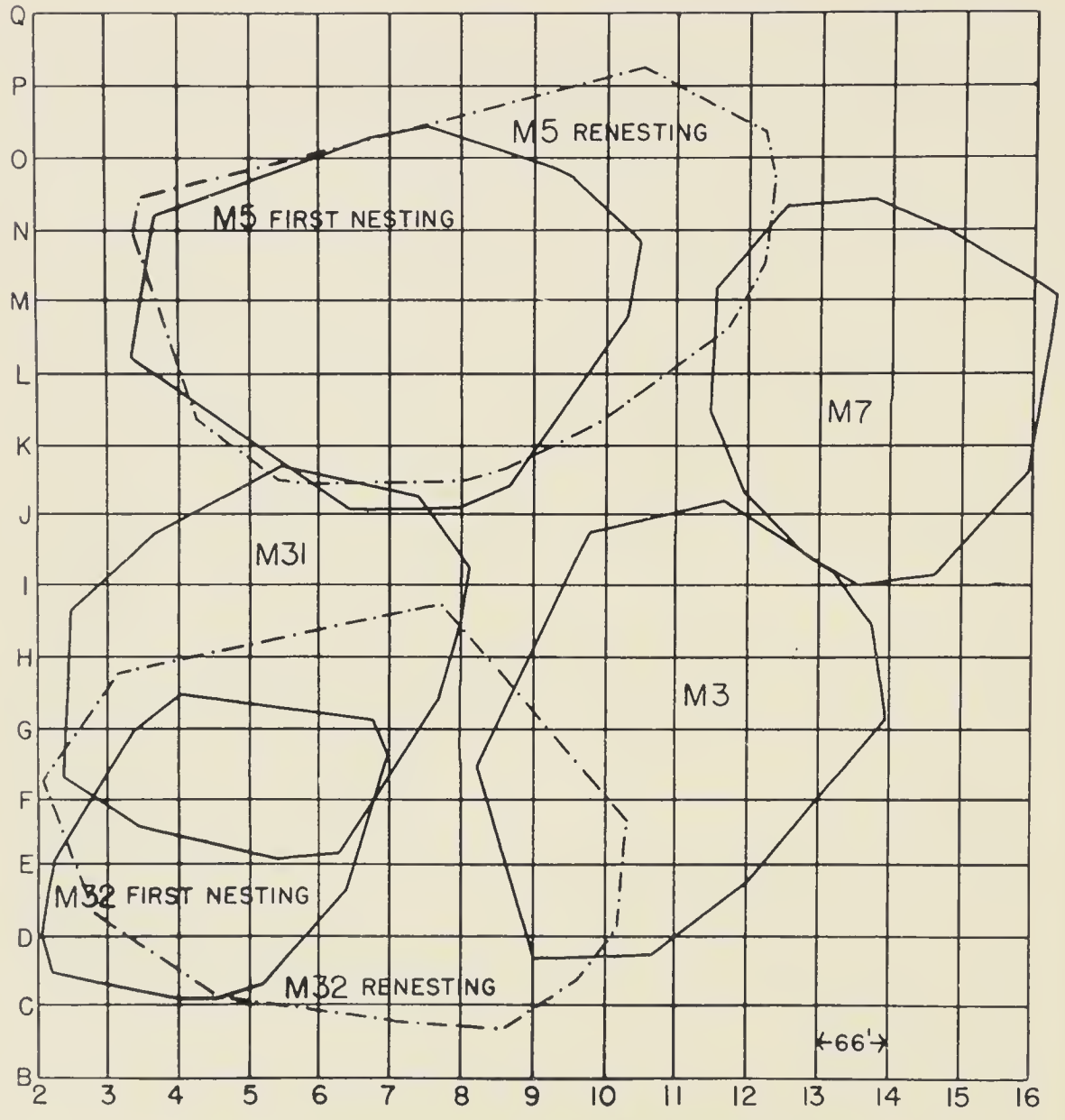

Fig. 3. Total utilized territories in Mixed Plot in 1956.

would necessitate measuring the height of each territory. Greater height might compensate for smaller area or height might be related to area in some other way.

The height of the space occupied by a male Ovenbird was estimated by finding the average height of the highest 25 per cent of points where the bird was observed. Analysis of data from territories of nine Ovenbirds showed that the vertical extent of activity was a little less than the height of the densest layer of the forest canopy. This resulted from the fact that Ovenbirds usually sang from the lower branches of the canopy. The vertical extent of activity was not clearly related to the area of the territory. Height values were less variable than areas of territories and did not compensate for them. Thus, if

volumes were calculated from these dimensions, they would be more variable than the corresponding areas.

These results, together with the fact that this species feeds and nests on the ground, indicate that, for the Ovenbird, the area of the total utilized territory is more meaningful than the volume of space occupied.

TABLE 3

VARIATION IN SIZE OF TOTAL UTILIZED TERRITORY AMONG FOREST TYPES

Forest type	1955		1956		
	Bird	Territory (acres)	Bird	Territory (acres)	
				First nest	Renest
Aspen	M 15	1.0	M 28	1.5	1.1
			M 26	1.9	
			M 27	2.1	
Conifer-birch			M 24	2.1	
			M 20	2.2	
			M 23	2.2	
Mixed	M 5[1]	0.8	M 5	2.7	3.6
	M 9	1.6	M 31	2.2	
	M 4	1.7	M 3	2.4	
	M 7	2.0	M 7[1]	1.8	
	M 10	2.1	M 32	1.5[2]	3.4
	M 2	2.8			
Maple	M 12	3.9	M 30	2.5	
	M 13	4.3	M 29	4.0	

[1] Unmated.
[2] Based on observations on only two days.

CHANGES IN UTILIZED TERRITORY AS THE BREEDING SEASON ADVANCES

A distinction can be made between the total utilized territory for the breeding season and the area utilized on one day. Changes in the area utilized daily may be observed as the breeding season advances.

The observation-area curve as a means of estimating utilized area.—Odum and Kuenzler (1955) used the observation-area curve as a standard method of measuring size of territory for comparative purposes. After each 10 consecutive observations were mapped, they plotted the area outlined by all the observation points against the total number of observations. At first, the area increased as more observations were included, but later the curve leveled off. Odum and Kuenzler selected as a standard, for comparison of different territories, the area obtained when there was less than one per cent increase in area for each additional observation.

This method has been modified and extended for the treatment of Ovenbird

data. Instead of mapping the location of a bird every five minutes, as Odum and Kuenzler did, all different locations where a bird was observed were recorded. This resulted in approximately 12 to 15 locations per hour. Points were plotted on the observation-area curve after each five consecutive observations.

In the present study there were a number of days when the birds were inactive. On such days, the number of locations visited by a bird were too few to reach the level portion (or the level of one per cent change) of the observation-area curve. Since the area utilized can change substantially from one day to the next in the case of the Ovenbird, there seemed to be no justification for combining observations made on different days and in different weeks. In order to reach the one per cent level on the observation-area curve, 60 or more locations were usually required and this number was obtained only two or three times for each bird during the breeding season. It was relatively easy, however, to obtain 30 to 40 locations on any one day. As few as 20 locations were sufficient to estimate the slope of the initial portion of the observation-area curve. This slope was estimated by calculating a line of best fit to the points on the initial portion of the curve.

The slope of the initial part of the observation-area curve is proportional to the area reached at the level portion of the curve. This is shown in Fig. 4, in which slopes of the initial portions of the curves are plotted against the final areas for all those occasions when the level portion of the curve was attained (at least the last three points at the same level). Points on the level portion of a curve were excluded in calculating the slope.

The relationship shown in Fig. 4 means that the rate of increase in area per observation is greater when the area is larger, and suggests that successive locations at which an Ovenbird is observed may be farther apart when the bird visits a larger area. This was tested by measuring the distances between consecutive observation points and comparing the mean distance obtained with the area reached at the level portion of the observation-area curve. Fig. 5 shows that distances between points were greater when the area utilized was larger.

Thus, there is a reasonable basis for relating the slope of the initial portion of the observation-area curve to the final area reached by the curve. This relationship was used to estimate the areas utilized by Ovenbirds on days when only enough data were obtained to calculate the slope of the initial portion of the curve. A line of best fit was calculated for the data in Fig. 4. Given a slope value, a corresponding area can be read from this graph or calculated from the equation of the line, $Y = .005 + .0199X$.

Estimates of utilized area obtained in this way should not be regarded as very accurate in view of the rather wide scatter in Fig. 4. Since the error is likely to be greater if the area is large, no definite values were assigned to

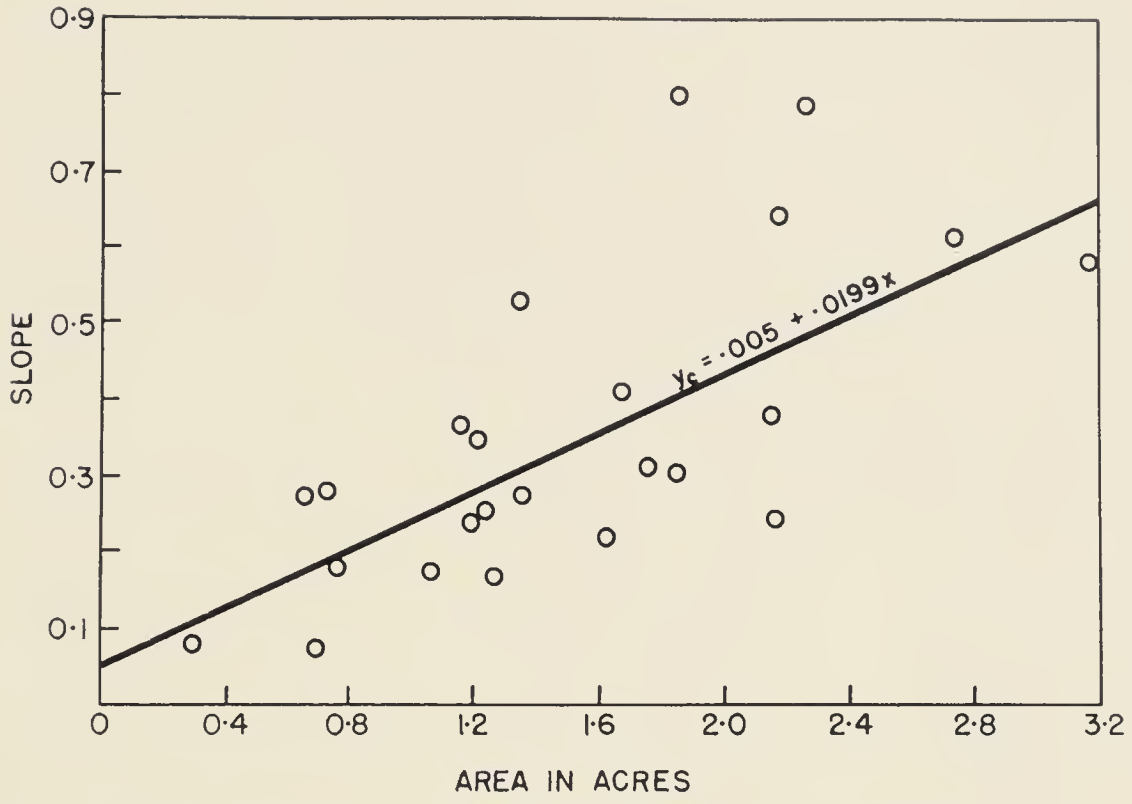

FIG. 4. Relation between slope of the initial portion of the observation-area curve and the final area reached by the curve. The line of best fit to these data is shown.

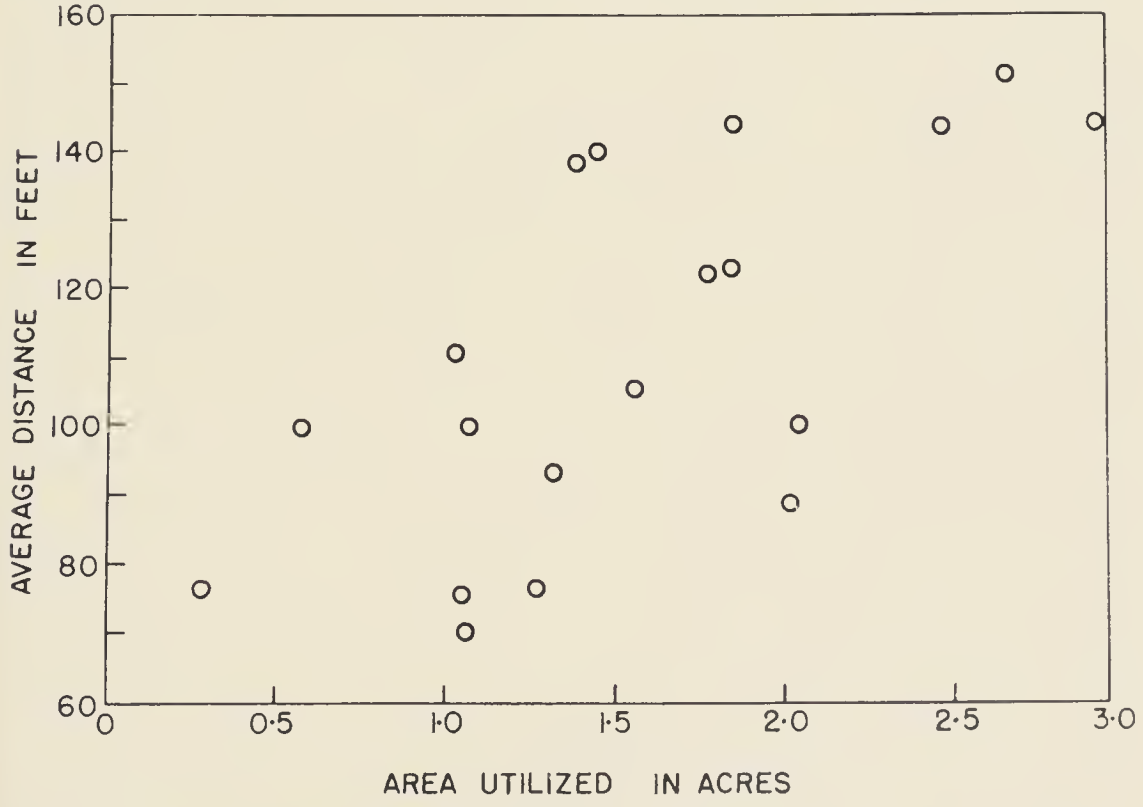

FIG. 5. Average distance between successive locations at which a bird was observed in relation to area utilized. Area utilized is taken to be the area reached at the level portion of the observation-area curve.

estimated areas in excess of four acres. This method made it possible to use data which would otherwise have been rejected as incomplete.

Changes in the area utilized by the male during the reproductive cycle.—The duration of the different stages of the breeding cycle were determined for a few Ovenbirds whose nests were found. Where nests were not found young birds were easily discovered after they had left the nest and could be aged approximately. Data on the breeding cycle obtained in this way agreed with the more extensive information given by Hann (1937); therefore his time intervals were used to fix approximate dates of the different stages of the breeding cycle for birds where only the young were found.

The following is a brief summary of the Ovenbird's breeding cycle:

Premating	—period from arrival of male to arrival of female; about 13 days in 1955, and about 18 days in 1956.
Mating	—a period of variable length from arrival of female until nest-building begins.
Nest-building	—5 days for first nest, 4 days for renesting.
Egg-laying	—3 to 5 days, depending on number laid.
Incubation	—12 days, beginning with second-last egg.
Nestling	—7 to 9 days.
Young leave nest	—young leave nest in about 9 days, fly in about 11 days, and are independent about 30 days after hatching.

Using the method outlined in the previous section, the area utilized by each bird in each observation period was estimated and the values obtained were assigned to the appropriate stages of the breeding cycle. These values, expressed as fractions of the total utilized territory, are shown in Fig. 6 for the 11 birds for which the necessary data were available. Since no one bird was studied during every stage of the breeding cycle. all the values obtained in each period were averaged and are shown in the final histogram. In interpreting these histograms, it must be borne in mind that measurements were not made at precisely the same stages for all the birds, even within the main periods of the breeding cycle.

Two major peaks in the size of the area utilized occurred during the breeding cycle (Fig. 6), one during the premating and mating periods, and the other during the incubation and nestling periods. During these two peak periods the average area utilized by the male in one day was almost as large as the total utilized territory. During the period between these peaks (nest-building and egg-laying) the average area was about half the size of the total utilized territory. These marked variations in area utilized can be explained in terms of the male's activities.

In the premating period, when the area utilized is large, the male establishes his territory. He sings often and encounters with other males are frequent. Six of eight males for which data are available showed an increase in area

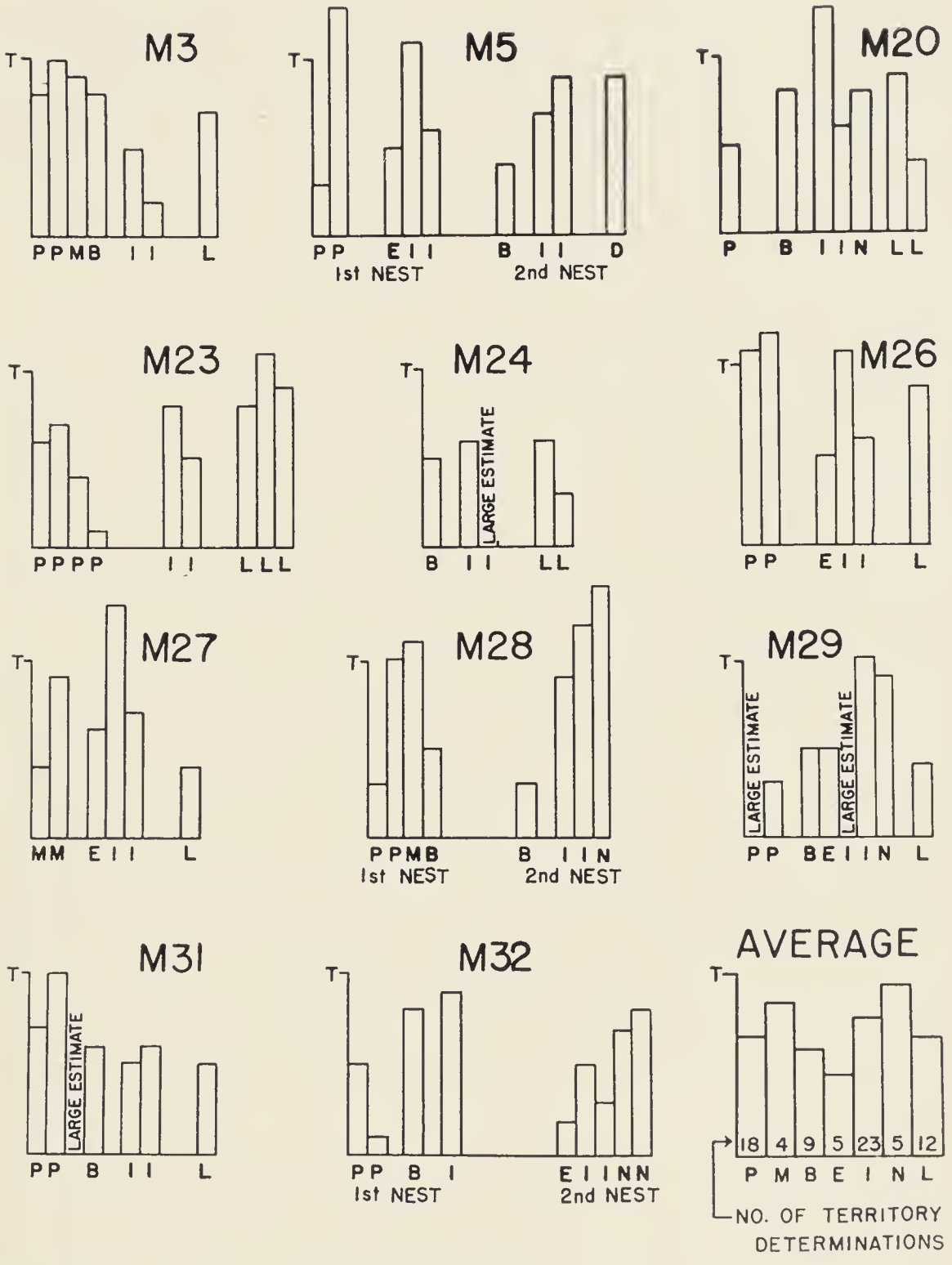

FIG. 6. Area utilized in different periods of the reproductive cycle expressed as a fraction of the total utilized territory (T) for each bird. Average values for all birds for each period of the reproductive cycle are given in the final histogram. Periods of reproductive cycle: premating (P), mating (M), nest-building (B), egg-laying (E), incubation (I), nestling (N), and after young have left nest (L).

utilized during this period. One bird (M 23) that had an extended premating period showed a decrease in the area utilized following the initial increase.

Three males were studied in the period between the arrival of the females and the beginning of nest-building. In this mating period the area utilized by the male was large.

From the time the female began building the nest until she started to incubate, the area utilized by the male was small (less than in earlier periods in 6 out of 8 cases). In this period the male sings infrequently and is often seen with the female although he does not help build the nest. Copulation takes place mainly in this period (Hann, 1937).

During the incubation period, the area utilized once again increased in 10 out of 12 cases. The male does not take part in incubation and is seldom seen with the female at this time. He sings about as often as during the premating period. Most males (8 out of 12) showed a small decrease in area utilized toward the end of this period.

During the nestling period the male helps feed the young. He sings infrequently and is secretive, and is therefore difficult to observe. Adequate data were obtained for only four birds, all of which utilized areas about as large as, or larger than during the incubation period.

When the young leave the nest the brood is divided between male and female. In this period some males (5 out of 10) utilized larger areas than previously, whereas others used smaller areas. If there are several young they tend to disperse rather than to stay together. It may be that males tending more than one young utilized a larger area during this period than those tending a single young bird.

Thus, the size of the area a male Ovenbird utilizes varies during the breeding season. It is large when he is occupied with territorial defense, advertising song, and food gathering for the young, and small when he spends his time with the female and copulation is frequent. While the areas utilized by males change markedly, no conclusions concerning the area utilized by females, or changes in size of defended territories can be drawn from the data presented in this paper.

Apparently the Ovenbird is somewhat different from certain other species in regard to changes in size of the territory occupied as the breeding season progresses. Young (1951) thought that territories of the Robin (*Turdus migratorius*) shrank progressively as the breeding season advanced, while Odum and Kuenzler (1955) found that for a number of species territories were smaller during the nestling stage than during nest-building and incubation.

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Summary

Territories of Ovenbirds were studied in four forest types in Algonquin Park, Ontario. Locations where a male was observed were used to estimate its *total utilized territory* for the breeding season. Birds were observed singing or feeding in all parts of their territories, although some birds did not utilize open areas. Total utilized territories of adjacent males were usually separated by a buffer zone but occasionally overlapped. However, areas used by adjacent males on any one day were always separated.

Total utilized territories varied from 0.8 to 4.3 acres, being small in an aspen stand, intermediate in size in conifer–birch and mixed stands, and large in a maple stand. Thus, the size of the territory increased with increasing height and density of forest canopy, and with decreasing vegetation near the ground. Unmated birds had small territories.

The vertical extent of each bird's activity was related to the height of the forest canopy where the bird sang, but not in any regular way to the area of its territory.

A method was developed to compare the areas utilized by male Ovenbirds on different days during the breeding season. The area utilized was large during the premating and mating periods, smaller during nest-building and egg-laying, and large again during the incubation and nestling periods. Thus, the area utilized by a male Ovenbird is large when he is occupied with territorial defense, song, and feeding the young, and small when he is often with the female and copulation is frequent.

Literature Cited

Brown, R. T., and J. T. Curtis

1952 The upland conifer–hardwood forests of northern Wisconsin. *Ecol. Monogr.*, 22:217–234.

Halliday, W. E. D.

1937 A forest classification for Canada. *Canada, Dept. of Northern Affairs and Nat. Resources, Forest Research Div., Bull.* 89:1–50.

Hann, H. W.

1937 Life history of the Oven-bird in southern Michigan. *Wilson Bull.*, 49:145–237.

Nice, M. M.

1941 The role of territory in bird life. *Amer. Midl. Nat.*, 26:441–487.

Odum, E. P. and E. J. Kuenzler
1955 Measurement of territory and home range size in birds. *Auk*, 72:128–138.
Stenger, J.
1958 Food habits and available food of Ovenbirds in relation to territory size. *Auk*, 75:335–346.
Toumey, J. W., and C. F. Korstian
1947 Foundations of silviculture upon an ecological basis (2nd ed., rev.). John Wiley and Sons, New York. 468pp.
Williamson, F. S. L.
1956 The molt and the testis cycle of the Anna Hummingbird. *Condor*, 58:338–367.
Young, H.
1951 Territorial behaviour in the Eastern Robin. *Proc. Linn. Soc. N.Y.*, 5:1–37.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, B.C.; AND DEPARTMENT OF ZOOLOGY, UNIVERSITY OF TORONTO, TORONTO, ONTARIO, CANADA, APRIL 23, 1958

THE SONGS OF THE GRASSHOPPER SPARROW

BY ROBERT LEO SMITH

In the spring of 1944 I began a four-year, life-history study of the Grasshopper Sparrow (*Ammodramus savannarum*) near Reynoldsville, Jefferson County, Pennsylvania. This paper deals with the songs; a second paper will cover the ecology and life history of the species.

The male Grasshopper Sparrow possesses three primary forms of vocalizations that I have designated the Grasshopper Song, the Sustained Song, and the Trill; and the female one, the Trill. Others (Eaton, 1914:292; Saunders, 1951: 254; Todd, 1940:630; Walkinshaw, 1940:56) have observed that the male sang at least two different songs, but apparently they attached little significance to this. After one summer of observations I was aware that each song more or less served a definite purpose and was characteristic of a particular period in the breeding cycle. Attention was given to this problem during the following seasons with emphasis on (1) the relationship of the songs to territorial establishment, mating and nesting; (2) the behavior of the birds while singing; and (3) the responses elicited in rival males and females.

During 1946 and 1947 a daily account was kept of the singing of 12 different males for a total of 14 individual records. Weather conditions, the different songs given during the day by each male, and song in relation to the time of day were recorded. In late summer when song diminished, observations began before dawn and concluded at dark in order to include any occurrence of song during this period.

Description of the Songs

Grasshopper Song.—The most familiar of all the songs of the Grasshopper Sparrow is the one from which the bird derives its name, the Grasshopper Song. It is one to three seconds in duration and possesses an insect-like quality which has been likened to the stridulations of the long-horned grasshopper (*Conocephalus*). The song has two variations, common to all individuals, and are represented as follows:

To the ear the Grasshopper Song is remarkably consistent. There does not appear to be the wide individual variations in song found in many fringillids. Extensive spectrographic studies probably would prove otherwise. I have met, however, with two outstanding exceptions. In the first instance the individual consistently sang a song that was remarkably similar to that of a cicada (*Tibicen* sp.). In the second instance the bird gave a weak, husky trill with great effort.

I have been able to deteet a reedy quality in the songs of other individuals, but this never proved to be a reliable means of distinguishing the individual from neighboring Grasshopper Sparrows.

The males sing the Grasshopper Song from a grass stalk, low bush, fenee post, 10 to 30 feet up in a tree, or from electric power lines. During the height of territorial establishment this song may be sung up to 220 times an hour.

The Sustained Song.—The seeond voealization of the Grasshopper Sparrow is more elaborate and more musieal than the Grasshopper Song and is subject to more individual variation. The Sustained Song, which may vary from five to 15 seeonds in length may be represented as follows:

At times the "grasshopper" introduetion is omitted and the song then eonsists of the last phrase only.

The Sustained Song is not eonfined to pereh singing alone. The male often sings it in flight, either alone or while pursuing the female. The male rises out of the grass on quivering wings, delivers this song in a low, fluttering flight and then drops down into the grass again.

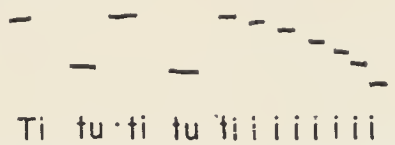
Even though this song ean be heard frequently during the mating and nesting season and during summer evenings, it is surprising how mueh confusion has developed regarding it. Saunders (1951:254) eonsidered what obviously is the Sustained Song as a post-season elaboration of the typieal Grasshopper Song. Todd (1940:630) stated that it probably was a mating song. Eaton (1914:292) stated that Gerald Thayer eonsidered this the true song of the speeies. Jouy (1881:58), apparently on mistaken identifieation, attributed this song to Henslow's Sparrow (*Passerherbulus henslowii*). He wrote:

"Besides their eharaeteristic note of *te-wick*, they have quite a song whieh may be fairly represented by the syllables *sis-r-r-rit-srit-srit*, with the aeeent on the first and last parts. This song is often uttered while the bird takes a short flight upward; it then drops down again in the tangled weeds and grasses where it is almost impossible to follow it."

This is an adequate deseription of the Sustained Song of the Grasshopper Sparrow whieh is often given in flight. Fortunately both the Grasshopper and Henslow's sparrows nested in the study area. Not onee in five years of observations of both species have I heard a Henslow's Sparrow sing a song that even remotely resembled the Sustained Song of the Grasshopper Sparrow. A similar view was given by Sutton (1928:179–182).

The Trill.—The male possesses still another voeal performanee, the Trill, whieh seems to be eonfined to mated birds. It is the least eommon of the voealizations and, unless one is frequently afield, it is apt to be missed entirely.

Saunders (1951:254) gives a graphic description of the Trill, although he does not seem to recognize it as a distinct type of vocalization. Walkinshaw (1940: 59) described it as a nesting song. It consists of a series of moderately loud notes on two tones, rapidly given:



It may be delivered either from a perch or in the grass.

The Trill of the Female.—The female Grasshopper Sparrow possesses a vocalization quite similar to the Trill of the male but it it weaker, suggestive of the Chipping Sparrow's (*Spizella passerina*) song and lacks the downward trill:

It is difficult to observe the female singing because, except in courtship flights, she delivers this song while concealed in the grass. On May 21, 1945, I had an excellent opportunity to observe the female uttering the Trill. She appeared in a small bare area in some rather sparse grass near the boundary of a hay and wheat field. Flirting her tail and hopping slowly about in a circle she delivered the Trill. Then she flew into the wheat where she sang it again.

The female may sing this trill in answer to the Sustained Song or the Trill of the male, or she may give it without the stimulus of the song of the male.

Periods of Song

Singing falls into seasonal and daily patterns (Fig. 1). The seasonal distribution of song is influenced by the reproductive cycle of the bird; the daily pattern is influenced by the seasonal pattern and by daily weather conditions.

Grasshopper Sparrows are in song when they return to their breeding areas in mid-April. The average date over a 5-year period for their arrival on the study area was April 16. The earliest arrival was March 31, 1945, the earliest ever recorded for western Pennsylvania, and the latest arrival was April 21, 1946. The entire population on the study area did not arrive at once, but built up over a period of a week. During the first days following their arrival the males sang only the Grasshopper Song and confined their singing to the morning hours. As the population increased during the succeeding days, the males sang the Grasshopper Song more and more frequently, until they were heard throughout the day.

Within 10 to 14 days after their arrival, the males introduced the Sustained Song. At first each male may sing this song no more than two or three times a day, but within a week he almost replaces the Grasshopper with the Sustained Song for a few days. In general, however, it is given interchangeably with the

Fig. 1. Frequency of song among Grasshopper Sparrows during summer, 1946.

Grasshopper Song and is rarely sung for any length of time without interruption by the Grasshopper Song.

After pairing all song appears to be inhibited for a few days, but the birds I observed never ceased singing entirely. During the period of egg-laying and incubation, the male sings both songs frequently, especially in the early morning and evening, continuing until darkness. Occasionally a bird may sing sporadically throughout moonlight nights.

During June, when most Grasshopper Sparrows are feeding young, song wanes. The Sustained Song is heard less frequently during the day and more or less assumes the status of a twilight song. The Grasshopper Song is again the common daytime song; but prior to renesting the Sustained Song becomes conspicuous for several days, then wanes again. By mid-July the Sustained Song has all but disappeared and is sung only occasionally from then until the cessation of song in mid-August. The Grasshopper Song, however, is retained

and is sung with diminished vigor and frequency as the summer wears on (Fig. 1).

After pair formation in late April the male introduces the Trill. He gives this infrequently and only on specific occasions. After nesting is completed and the young are on the wing, the male drops the song.

The Trill of the female is heard from the time of pair formation to the cessation of nesting.

The Grasshopper Sparrow does not have an extended morning awakening song. Upon awakening the bird may remain silent and start to feed, it may utter the *chi-ip* call note or it may sing the Sustained or Grasshopper Songs. Once the bird commences singing, it interrupts the song sequence frequently with feeding.

By mid-July the daily pattern gradually assumes a different character. The Sustained Song is dropped except for a few occasional days when it may be given several times in the very early morning or at evening twilight. Morning song has nearly ceased and daytime song is rarely heard. The cooler temperatures of evening and the suspension of feeding activity bring in the twilight song which lasts until darkness comes. At this period the Sustained Song, with its greater carrying power, seems to be the most conspicuous and for this reason has been erroneously described as a post-season elaboration of the regular song of the species.

Song may be inhibited by adverse weather conditions. For example, in 1945 spring came exceptionally early. In late March temperatures were in the high 70's and low 80's, leaves were opening and the grass was three inches high. As might be expected, the Grasshopper Sparrows returned very early, on March 31. Song increased in volume up to May 1, when cold, wet weather set in. Song nearly ceased. On May 9 the weather cleared, and although the temperature was 30°F., all Grasshopper Sparrows broke into song. Hot, humid weather also has an inhibiting effect on song, but not to the extent of cold, wet weather.

Functions of Song

The objective study of the function of bird song has suffered from the lack of a suitable definition of bird song. Howard (1920) in his pioneer work on territorialism in birds emphasized the advertising function of song. Tinbergen (1939:73) regarded bird song as an utterance "that serves to attract a sex partner, to warn off a bird of the same sex or both." Nice (1943:144–149) and Lack (1943:28–33) also considered song from this viewpoint. More recently, Moynihan and Hall (1954:50) suggested that the term "song" be confined to those vocalizations with the dual functions of warning rivals and attracting mates. On the other hand, Armstrong (1947:294) stated that from a functional point of view no distinction can be drawn between songs and calls.

For the purposes of this paper, and of attempting more clearly to distinguish song from other vocalizations of a bird. song is regarded as a vocal utterance, long or short, simple or complex and species specific, which is given by either sex or both and which functions primarily to repel rivals of the same species, to attract a mate, or both.

This definition is exclusive to the point that it eliminates any vocalizations, however complex, which do not serve primarily to attract or repel. At the same time it does not assume that song is exclusively the function of the male. It thus includes the rarer instances of song in female birds. The words "functions primarily" do not eliminate the post or pre-breeding season songs of many birds. Other musical utterances not serving to attract or repel should be considered sub-songs and all other vocalizations as calls.

The Grasshopper Song.—Its peak occurrence early in the season and its consistent appearance in daytime and evening singing up to the complete cessation of song suggest that the Grasshopper Song is territorial in function.

The behavior of the bird itself, however, is even stronger evidence that the song is hostile. During territorial establishment the male alternates song with display. In a crouched position with his head lowered between his shoulders (Fig. 2, A), the male raises and flutters one or both wings (Fig. 2, B). The primaries and secondaries are not extended, but the wing is fluttered quickly above the back at the humerus. Then, after hearing the song of his neighbor, the bird stands erect and sings back (Fig. 2, C). The song completed, the male again assumes the crouched position and flutters his wings. The sequence is as follows: (1) The male stands erect and sings the Grasshopper Song. (2) Song completed, he assumes the crouched position. (3) He flutters one wing or both simultaneously. (4) He hears rival's song, and rises to a singing position. (5) He sings Grasshopper Song.

The wing-fluttering of the Grasshopper Sparrow is never accompanied by a song or a call, but is confined to that interval between songs, and is conspicuous only during the period of territorial establishment.

It seems unusual that this behavior has not been reported by other writers. The only comment on wing-fluttering by the Grasshopper Sparrow that I have found was made by William Brewster (1874) in his unpublished Nantucket journal for July 3, 1874: ". . . I have a new one, namely that the bird frequently quivers its wings like a Bluebird."

Wing-fluttering is closely associated with territorial establishment. Some manner of wing-fluttering occurs in the mating and territorial behavior of a number of passerine species, for example, the Snow Bunting, *Plectrophenax nivalis* (Tinbergen, 1939:17); the Song Sparrow, *Melospiza melodia* (Nice, 1943:154); the House Wren, *Troglodytes aedon* (Kendeigh, 1941:21); the European Wren, *Troglodytes troglodytes* (Armstrong, 1954:47, 114–117); the European Goldfinch, *Carduelis carduelis* (Hinde, 1955:720); the Canary,

Serinus sp. (Hinde, 1955:713–715); and the Greenfinch, *Chloris chloris* (Hinde, 1955:719). The stimuli for these displays differ from those of the Grasshopper Sparrow. One male has actually invaded or is threatening to invade the territory of another; the birds see one another; or often they are face to face. The Grasshopper Sparrows in most instances do not see one another. The males may be hidden from one another by the vegetation or the topography of the field. They do not erect the body feathers. The attitude, however, of the male between songs, the crouched posture with the bill pointed forward, the fluttering of the wings, the apparent readiness of the bird to move forward to meet a threat, all strongly indicate that this is a hostile display. During the period of territorial establishment the song of a rival is a sufficient stimulus to release this display. The bird senses the presence of a rival by the sound of his song and manifests this by a hostile display, as if the rival were nearby in the grass. Marler (1956:497) has observed a similar reaction in the Chaffinch (*Fringilla coelebs*). The song of the Chaffinch played through a loud speaker induced fierce aggressive display in males.

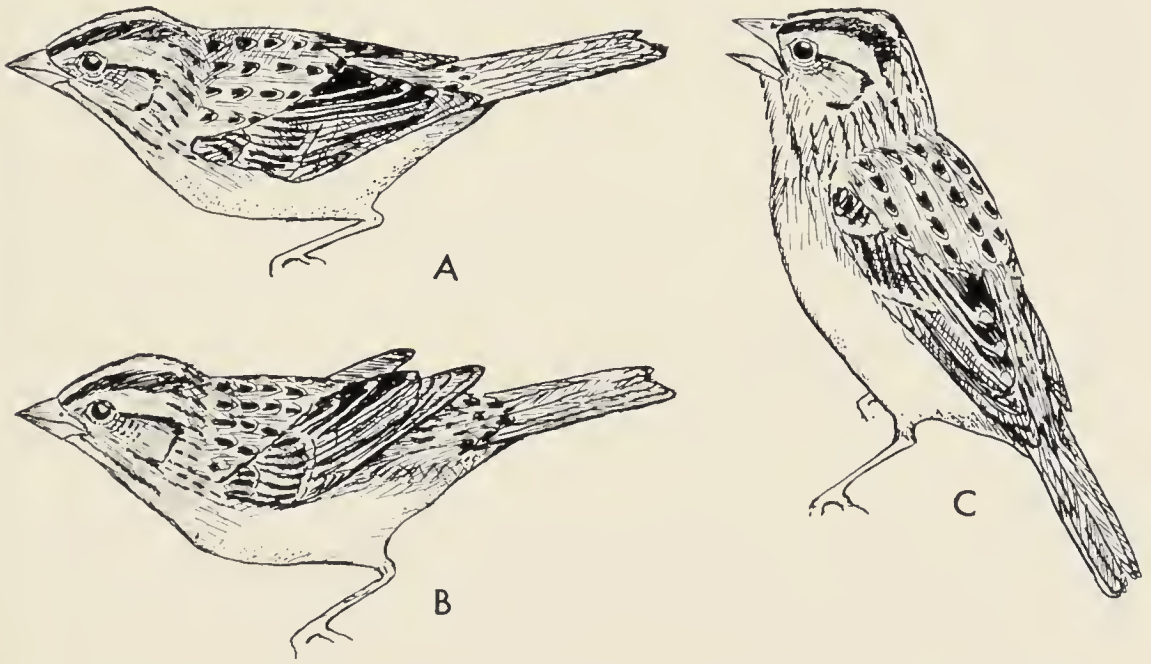


FIG. 2. Attitudes of male during the Grasshopper Song sequence. (A) crouched position. (B) Wing-fluttering. (C) Delivering song.

Unfortunately I have never observed among Grasshopper Sparrows a territorial dispute that elicited a high intensity intimidation display. If any occurred it happened out of sight in the grass. The only physical encounters I have observed during hundreds of hours spent with the species were those after a bird saw another invade its aerial territory. In each instance the bird chased the intruder, then retired to a singing perch, fluttered his wings and sang the

Grasshopper Song. I have witnessed a number of aerial clashes at disputed territorial boundaries. In fact, this mode of defense could be the most important, because the deep grass would generally conceal territorial infringement on the ground. Perhaps the Grasshopper Sparrow recognizes the limits of its territory only from a grasstop point of view.

The Grasshopper Song, then, serves primarily as an advertising or territorial song. The distribution and occurrence of this song during the season, its timing, and the response it elicits from neighboring males emphasizes this function. It is the first song given by the male in the spring and is delivered from the highest perch in the territory. It is sung when one male is chasing another from his territory, and is delivered by both when the two retire to their singing posts.

At times the Grasshopper Sparrow will deliver the Grasshopper Song while protesting other animal or human intrusion. On occasions male Grasshopper Sparrows protested my presence in their territories. As soon as I left they would return to their singing perches and deliver the Grasshopper Song.

The Sustained Song.—The Sustained Song attracts a mate. Its occurrence in the seasonal song cycle, its loudness, and the response it elicits from the female indicate this function. Upon hearing the Sustained Song, the female will answer the male with a Trill (Fig. 3). In turn, the male will respond to the female's vocalization by answering her with the Sustained Song again, or by flying to her.

The function of the Sustained Song cannot be limited to attracting a mate. If that were its sole purpose it should cease upon the arrival of a female, as in the case of the Snow Bunting (Tinbergen, 1939:77). The song, however, is delivered through the periods of nesting and caring for the young. Furthermore, it is given with increased frequency just prior to the second nesting. Apparently this song is quite important in maintaining the pair bond throughout the season.

The complete Sustained Song with the "grasshopper" introduction is hostile to other males. The first phrase of the song is identical to the Grasshopper Song. This is necessary in the early period of courtship because the territories have been newly settled by the males and the warning function still is of prime importance. The second phrase of the song, however, serves to attract and hold a mate. Later in the season, when territories are well established and the warning is not so imperative, the majority of Sustained Songs lack the "grasshopper" introduction. When one male hears another singing the Sustained Song, he responds not with the Sustained Song but with the Grasshopper Song. Then both birds launch into a song duel of Grasshopper Songs.

The Trill.—The Trill generally is not given by the male until the pair is formed and even then it is usually uttered only in the vicinity of the nest, and only from a perch or in the grass. It may follow one of the other two songs or it may be given alone, often in answer to the female (Fig. 3). It is also given by the male when he is in close proximity to the nest.

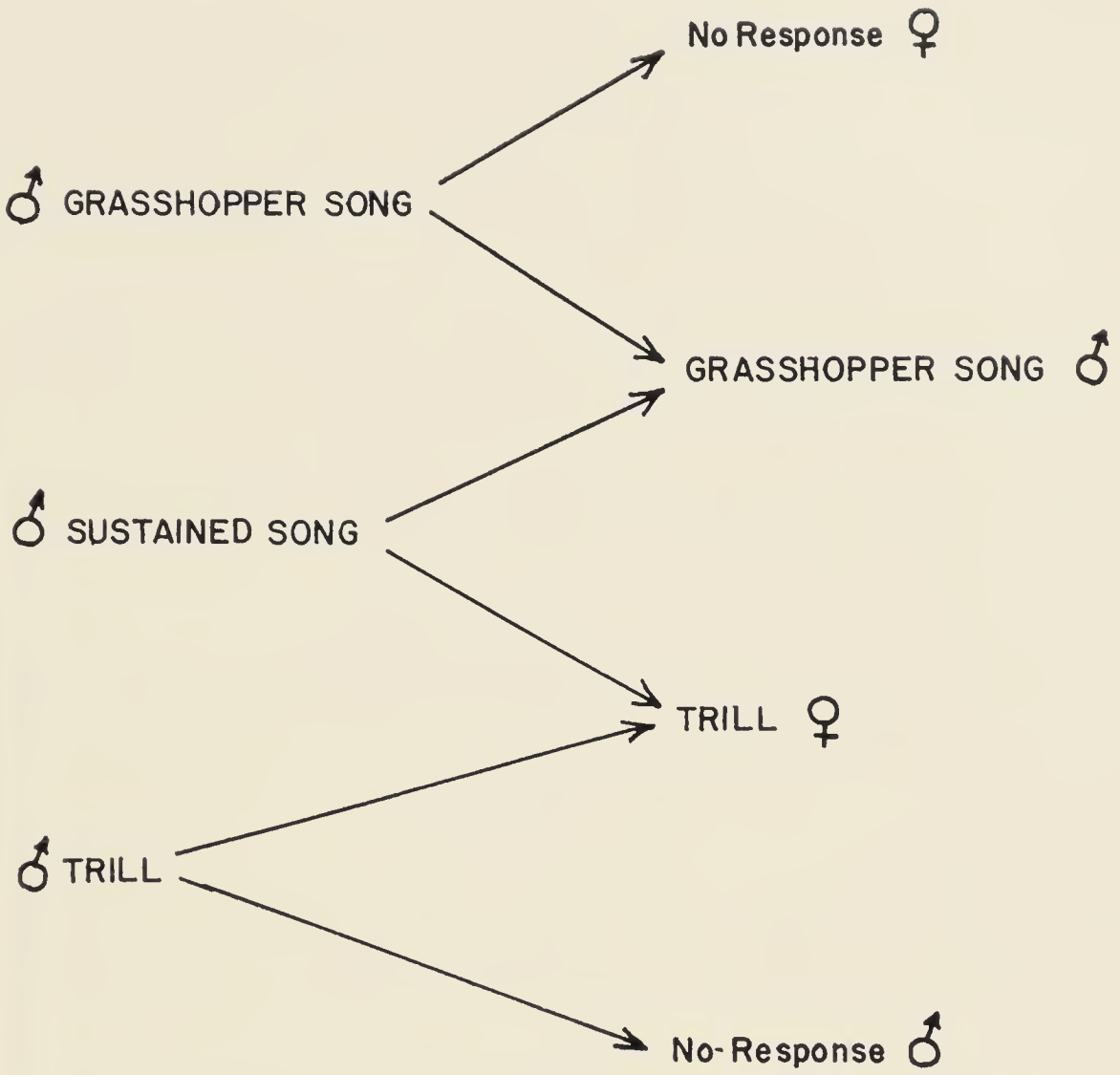


FIG. 3. Responses of male and female Grasshopper Sparrows to the several songs.

The Trill apparently serves as a bond to hold the pair together, and as a signal to both the female and the young that the male is approaching the nest. The fact that the Trill usually is given only by the mated male seems further to support this function. Only once did I hear the Trill given by an unmated male, several of which I have followed through a season.

The Trill of the Female.—The Trill is a distinctive vocalization of the female which may or may not be given under the stimulus of the song of the male. The fact that the female Grasshopper Sparrow vocalizes should not be regarded as unusual, but the problem is whether or not this vocalization can be regarded as true song.

The manner and circumstances under which the Trill of the female is sung, and its function, indicate that it can be. Just as the male Grasshopper Sparrow can detect the presence of a rival in his territory by the rival's song, so can he

detect the presence of a female by some distinctive signal. Herein lies the significance and the biological importance of the female's song. When the male sings the Sustained Song, he proclaims his availability to a female. A female bird present on his territory answers with a vocal performance which is loud, species specific, and which advertises her presence to the male. In fact she sings this Trill independent of any song from the male. Hearing the female, the male flies to her.

The importance of the female's song as an attracting mechanism is apparent. The male does not have to see by chance a strange bird in his territory and then challenge it to determine its sex. Because of the nature of the habitat this might be difficult and time consuming. Instead, the song of the female assures that the male will be led to a potential mate, that this potential mate is of the male's own species and that the male will have the opportunity to find a mate at the proper time in the breeding cycle.

The female also gives the Trill when she is approaching, or is in the vicinity of the nest.

The primary function of the Trill of the female Grasshopper Sparrow is to declare her presence to the male, to announce her location, to maintain the pair bond, and to signal both the male and the young that she is approaching the nest.

Acknowledgments

For comments and suggestions I am indebted to Merrill Wood, Charles G. Sibley, Ralph Palmer and the late Josselyn van Tyne. I wish to thank the librarians at the Museum of Comparative Zoology, Harvard University, for their assistance in securing all the notes on the Grasshopper Sparrow from the unpublished journals of William Brewster, and for permitting me to examine them.

Summary

The male Grasshopper Sparrow possesses three primary forms of vocalizations, the Grasshopper and Sustained Songs and the Trill, and the female Grasshopper Sparrow one, the Trill.

The male sings the Grasshopper Song from mid-April to mid-August. The Sustained Song is introduced approximately at the time the females arrive. It is sung with diminished vigor until mid-July and only sporadically from then on until the cessation of song in mid-August. The Trill is given from the period of pair formation to the completion of nesting, as is the Trill of the female.

Early in the season song is heard throughout the day. After mating, song is inhibited but does not cease entirely. During the periods of nest-building, incubation and care of the young, song is confined primarily to morning and late evening. Song is inhibited by adverse weather.

The Grasshopper Song is the familiar song of the species. It is used primarily to proclaim and defend territory. During the period of territorial establishment the male assumes a crouched, bill-forward position and flutters his

wing or wings between songs. This is regarded as a hostile display released by the song of the rival.

The Sustained Song in its entirety consists of a "grasshopper" introduction and a sustained series of melodious notes. After the territories are well established, the "grasshopper" introduction is usually dropped. The primary function of the Sustained Song is to attract a mate, but the "grasshopper" introduction is hostile in character. A secondary function of the song is to maintain the pair bond.

The Trill serves to maintain the pair bond and to signal the mate and the young of the male's approach to the nest. It apparently is given only by mated males.

The Trill of the female advertises the presence of a potential mate in the male's territory and identifies her species and sex. The Trill also serves to maintain the pair bond and to signal the male and the young that she is approaching the nest.

The male Grasshopper Sparrow responds to the Grasshopper and Sustained Songs with a Grasshopper Song, to the female's Trill with a Sustained Song or a Trill. There is no response by the male to the Trill of another male. The female responds to the Sustained Song and the Trill of the male with her Trill, but shows no apparent response to the Grasshopper Song.

Literature Cited

Armstrong, E. A.
1947 Bird display and behaviour. Oxford Univ. Press, New York.
1954 The wren. Macmillan Co., New York.

Brewster, W.
1874 Unpublished journal. Library of Museum of Comparative Zoology, Harvard Univ., Cambridge.

Eaton, E. H.
1914 Birds of New York, Vol. 2. Univ. of State of New York, Albany.

Hinde, R. A.
1955 A comparative study of the courtship of certain finches (Fringillidae). *Ibis*, 97:706–745; 98:1–23.

Howard, H. E.
1920 Territory and bird life. Murray, London.

Jouy, P. L.
1881 Description of the nest and eggs of *Coturniculus henslowi* obtained near Falls Church, Va. *Bull. Nuttall Ornith. Club*, 6:57–58.

Kendeigh, S. C.
1941 Territorial and mating behavior of the House Wren. *Ill. Biol. Mono.*, 18(3).

Lack, D.
1943 The life of the Robin. H. F. & G. Witherby, London.

Marler, P.
1956 Territory and individual distance in the Chaffinch *Fringilla coelebs*. *Ibis*, 98: 496–501.

Moynihan, M. and M. F. Hall
1954 Hostile, sexual and other social behavior patterns of the Spice Finch (*Lonchura punctulata*) in captivity. *Behaviour*, 7:33–76.

Nice, M. M.
1943 Studies in the life history of the Song Sparrow II. *Trans. Linn. Soc.* N. Y., 4: 1–247.

Saunders, A. A.
1951 A guide to bird songs. Rev. ed. Doubleday, Garden City.

Sutton, G. M.
1928 The birds of Pymatuning Swamp and Conneaut Lake, Crawford County, Pennsylvania. *Ann. Carnegie Mus.*, 18:19–239.

Tinbergen, N.
1939 The behavior of the Snow Bunting in spring. *Trans. Linn. Soc.* N. Y.

Todd, W. E. C.
1940 Birds of western Pennsylvania. Univ. Pittsburgh Press, Pittsburgh.

Walkinshaw, L. H.
1940 Some Michigan notes on the Grasshopper Sparrow. *Jack-Pine Warbler*, 18: 50–59.

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FOOT-STIRRING FEEDING BEHAVIOR IN HERONS

BY ANDREW J. MEYERRIECKS

A PECULIAR type of feeding behavior, described by various authors as "stirring," "scraping," "raking," and so on, has been recorded for several species of herons and other birds (see, for example, Rand, 1956). Briefly, the feeding heron extends one leg and vibrates or quivers it, especially the foot, then stabs at any prey that darts from the disturbance. The purpose of this paper is to describe my observations of this behavior in three North American heron species, and to give several examples of apparent "footedness" (i.e., preference for one foot while foot-stirring) in these same species. My observations concern the Snowy Egret (*Leucophoyx thula*), Reddish Egret (*Dichromanassa rufescens*), and the Louisiana Heron (*Hydranassa tricolor*). All three species were observed in Florida Bay and around the Laguna de la Joyas, near Puerto Arista, Chiapas, Mexico. Additional observations of the Snowy Egret were made on Rulers Bar Hassock, Jamaica Bay, western Long Island, New York, and near Tehuantepec, Oaxaca, Mexico.

Use of the Feet

Snowy Egret.—In Florida Bay, the clearness of the water and the relative tameness of this species offered exceptional opportunities to see the feet during this behavior. The whole body, particularly the extended leg, vibrates, and these movements seem to impart a stirring motion to the foot. Usually the bird stirs the substrate, but on several occasions I could clearly see individual birds stir the foot above the surface of the mud, not in it. The bright yellow toes of *thula* are sharply set off from the black legs, and when one of these egrets stirs above the substrate, I get the impression that it is using its foot as a lure.

Stirring is probably the best description of the motion of the foot, but at times N. B. Moore's term "raking" is more appropriate (Baird *et al.*, 1884). When raking, Snowy Egrets extend one leg, then rake the substrate by short, rapid movements of the toes. I saw that this species usually rakes mud, but it tends to stir aquatic vegetation. For example, while using this feeding method on the shallow reefs near Cowpens Cut in Florida Bay, several Snowy Egrets concentrated on stirring tufts of turtle grass (*Thalassia*). When a fish darted from one tuft to another, the egret peered at the tuft, stirred it until the fish moved again, then repeated this procedure until it made a successful strike or moved to a new location. Stirring tufts of turtle grass by *thula* resembles the weed-stirring of the Reef Heron (*Demigretta schistacea*) seen by Hartley (Gibb and Hartley, 1957).

However, when feeding in the shallow muds of Dove Creek slough on Key Largo, Florida. Snowy Egrets tended to rake more than stir. Perhaps different

kinds of prey are taken by stirring and raking; however, fish is the only food I have seen Snowy Egrets secure by either method.

The usual movements made by a Snowy Egret foot-stirring are "stir-peer-stab" or "stir-stab." However, one bird stirred continuously for about one minute, then it twirled about with open wings as it chased several fish forced to move by the egret's activities. Another individual raked the mud of Dove Creek slough until an area of about 100 square feet had been roiled, then the bird ran through the muddied water with open wings, stabbing to the right and left at the harried fish.

The Snowy Egret also shows an interesting aerial variant of this feeding method that I call "hovering-stirring." Sprunt (1936) saw a Snowy Egret hover and pat the surface of the water, while Bond (1934) and Grimes (1936) both observed *thula* feed on the wing. N. B. Moore (Baird *et al.*, *op. cit.*) saw a flock of Snowy Egrets feed by hovering over a shoal of minnows, but apparently none of these authors saw the egrets stir the water while feeding. My observations of hovering-stirring were made in Florida Bay, and typically the feeding egret hovered over one spot, dangled one or both legs, then stirred a tuft of grass or some debris until the prey was forced to move. The strike was always made from the hovering position.

"Foot paddling," in which the legs and feet are moved rapidly up and down on the substrate, has been recorded for *Leucophoyx thula* and *Egretta garzetta* in the Amsterdam Zoo by Portielje (1928). This behavior is very similar to the paddling of many gulls and waders (see discussion in Tinbergen, 1953). I have seen paddling in *thula* on one occasion (Rulers Bar Hassock, May 15, 1954). A single Snowy Egret was stirring in the manner described, when suddenly it stopped, paddled vigorously for about 20 seconds, then resumed stirring. The paddling movements were clearly distinct from those used in stirring.

Reddish Egret.—The foot-stirring of this species differs from that of the Snowy Egret in the following ways: 1) *rufescens* does not extend its leg forward and vibrate it, but simply vibrates its feet as it wades forward in a normal manner; 2) the foot is not moved in a stirring motion but rather it is scraped or raked over the surface of the mud; and 3) *rufescens* scrapes both mud and aquatic vegetation, even when hovering (see below). N. B. Moore (Baird *et al.*, *op. cit.*), commenting on the scraping behavior of *rufescens*, states that "It is a mode peculiar to this species, and not to be mistaken for that of any other."

Motion pictures I took of one Reddish Egret using this feeding method clearly show the scraping movements so typical of this species. The foot is moved rapidly back and forth as the bird slowly wades forward, and the toes appear to scrape or rake the substrate. Of the many Reddish Egrets I have watched using this method, none made stirring movements.

When scraping, *rufescens* almost always uses the technique "scrape-peer-stab." Typically, the feeding bird wades forward slowly, scraping as it goes, then it stops and peers intently at the surface of the water, and then it either stabs at some prey or moves on, usually resuming the scraping movements. As mentioned, in areas where tufts of aquatic grass abound, Reddish Egrets move these plants in search of prey by scraping, not stirring.

This species also shows the aerial variant "hovering-scraping." When hovering over the water, *rufescens* is an extremely agile, graceful species as it moves effortlessly from tuft to tuft. The legs of the bird are dangled, and the plants are agitated by scraping motions of the feet. As with the Snowy Egret, *rufescens* strikes from the hovering position. Although quantitative evidence is lacking, I believe that *rufescens* uses the hovering method more frequently than *thula*.

Louisiana Heron.—This species resembles the Snowy Egret in that it extends one leg and foot forward and then vibrates it rapidly, thus imparting a stirring motion to the foot. I have never seen tuft-stirring in *tricolor*, but I did observe that this species always stirs mud, unlike *thula*, which may stir or rake it. I have never seen hovering-stirring in *tricolor*.

McIlhenny (1936) claims that the Louisiana Heron uses foot-stirring during the winter only, "when the water is cold and their food supply inactive." This was not the case in the winter of 1955–56 in Florida Bay. All of the stirring observations I made of *tricolor* were recorded during warm periods, and I was able to see the tiny fish the herons were preying upon moving about quite actively. For example, the air temperature at Cowpens Cut on April 6, 1956, at 1130 hours was 85 degrees F., and the fish sought by the herons were constantly moving about my boat. On this date I watched a Louisiana Heron foot-stir for three minutes.

Duration of Foot-stirring

Of the three species I have watched, the Snowy Egret uses foot-stirring as a feeding method more often and for longer periods than the other two. N. B. Moore (Baird *et al., op. cit.*) also observed that *thula* uses this technique more frequently than *tricolor* and *rufescens*. Table 1 was made by selecting comparable observations from my field notes. Only those records made of all three species using foot-stirring feeding behavior on the same day in the same place are listed. One bird only was watched during the entire period of observation, and the duration of foot-stirring was recorded with a stopwatch. A glance at Table 1 shows that the Snowy Egret uses foot-stirring for longer periods than do the Reddish Egret and the Louisiana Heron.

Table 2 lists observations of foot-stirring in these same three species that are not comparable as to day, place, and so on, but the data support my belief that Snowy Egrets use this feeding method more often and for longer periods than the other two species.

The few records I have of feeding success while using foot-stirring (see Tables 1 and 2) show that the method is effective. N. B. Moore (*op. cit.*) watched a flock of 70 Snowy Egrets on February 18, 1873, and "scarcely one of this species obtained food without raking for it, numbers being thus engaged at the same time." All of the successful strikes listed in the tables were made on small fish.

TABLE 1

DURATION OF FOOT-STIRRING AND FEEDING SUCCESS IN THREE SPECIES OF HERONS

Species		Place and date			
		Florida Bay			Chiapas, Mexico
		December 16, 1955	March 11, 1956	March 12, 1956	June 24, 1956
Leucophoyx thula	Period[1]	63	27	19	17
	Duration[2]	13	26	15	12
	Success[3]	3/10	5/9	2/17	1/5
Dichromanassa rufescens	Period	150	41	75	8
	Duration	2	3	4	2
	Success	1/4	1/8	1/11	0/0
Hydranassa tricolor	Period	35	57	83	6
	Duration	1	2	1	1
	Success	0/0	0/3	1/1	0/0

[1] Total period of observation in minutes.
[2] Duration of foot-stirring in minutes.
[3] Number of successful strikes/total strikes while foot-stirring.

TABLE 2

FREQUENCY AND DURATION OF FOOT-STIRRING AND FEEDING SUCCESS IN THREE SPECIES OF HERONS[1]

Species	Number of observations	Total observation period in minutes	Total duration of foot-stirring in minutes	Strike success[2]
Leucophoyx thula	10	319	87	17/62
Dichromanassa rufescens	5	470	10	4/23
Hydranassa tricolor	4	120	8	4/17

[1] All of the separate observational periods are combined, as are the duration of foot-stirring and strike success.
[2] Number of successful strikes/total strikes while foot-stirring.

Footedness

I have the following four records of footedness in herons while using foot-stirring feeding behavior: Snowy Egret, 2 (both right); Reddish Egret, 1 (right); and Louisiana Heron, 1 (left). All four individuals used the foot indicated for the entire duration of foot-stirring. These clear cut preferences differ from Hartley's (Gibb and Hartley, 1957) observation of a Reef Heron that used "either foot, but the right more often than the left, to stir tufts of weed to bolt small fishes." Some Snowy Egrets I watched seemed to "lean" toward the use of one foot during an extended period of foot-stirring, but none of these birds was as clear cut in its preference as those cited.

Foot-stirring in Other Herons

I found many references to the foot-stirring feeding behavior of various herons, but Rand (1956) mentions only *thula* and *tricolor*. Prior to my own observations of *rufescens*, only those of N. B. Moore (Baird *et al.*, *op. cit.*) appear to have been available for this species. However, a number of observations of this feeding method have been made in several Old World species of herons. Hartley's record for the Reef Heron has been mentioned, while White (1946), Hopkins (1948), Koenig (1952), and Hobbs (1957) have seen foot-stirring in the Little Egret (*Egretta garzetta*). In Australia, Hopkins (1948) saw this feeding method in the Pied Heron (*Notophoyx picata*), and Hobbs (1957) observed foot-stirring in the White-faced Heron (*Notophoyx novaehollandiae*).

I have never seen foot-stirring in the Common Egret (*Casmerodius albus*), and several authors comment on the absence of foot-stirring in this species (e.g., Rand, 1956; Hobbs, 1957). However, Bagg and Eliot (1937), citing the observation of F. A. Stebbins and A. M. Bowen, state that "the Egret [i.e., *albus*] waded deeper, and when on a muddy bottom would, with the aid of his wings, hop straight up clear of the water and come down with stiff, spread toes, and then scrutinized the 'roil' he had caused for dislodged prey. He swallowed several fish." Although it is not foot-stirring, this observation suggests that some herons may effectively secure food by a feeding method using the legs and feet to disturb the prey without recourse to stirring or scraping.

Discussion

The bright yellow toes of *thula* and *garzetta* are sharply set off from the black legs, and both species use foot-stirring feeding methods. This distinctive pattern suggests that it may have evolved in conjunction with this peculiar feeding technique. However, the feet of *thula* turn a brilliant coral orange during the early part of the breeding season, and the feet are conspicuously displayed at this time (Meyerriecks, 1958). In addition, the feet of *garzetta* become crimson-pink during the breeding season (Henry, 1955), but the displays of

the Little Egret are not known in detail. It is possible that the feeding function of this pattern is primary and the display function secondary; however, both functions will reinforce the selection of bright feet. More information on the frequency and duration of foot-stirring in herons is needed before any conclusions can be made.

Literature Cited

Bagg, A. C., and S. A. Eliot, Jr.
1937 Birds of the Connecticut Valley in Massachusetts. The Hampshire Bookshop, Northampton.

Baird, S. F., T. M. Brewer, and R. Ridgway
1884 The water birds of North America. Vol. I. Little, Brown, & Co., Boston.

Bond, R. M.
1934 A partial list of birds observed in Haiti and the Dominican Republic. *Auk*, 51:500–502.

Gibb, J. and P. H. T. Hartley
1957 Bird foods and feeding-habits as subjects for amateur research. *Brit. Birds*, 50:278–291.

Grimes, S. A.
1936 On an unusual feeding habit of the Snowy Egret. *Auk*, 53:439.

Henry, G. M.
1955 A Guide to the Birds of Ceylon. Oxford Univ. Press, London.

Hobbs, J. N.
1957 Feeding habits of some water birds. *Emu*, 57:216.

Hopkins, N.
1948 Birds of Townsville and District. *Emu*, 47:331–347.

Koenig, O.
1952 Ökologie und Verhalten der Vögel des Neusiedlersee-Schilfgürtels. *Jour. f. Ornith.*, 93:207–289.

McIlhenny, E. A.
1936 Unusual feeding habits of some of the Ardeidae. *Auk*, 53:439–440.

Meyerriecks, A. J.
1958 Comparative breeding behavior of some North American herons. Ph.D. Thesis, Harvard Univ., Cambridge.

Portielje, A. F. J.
1928 Zur Ethologie bezw. Psychologie der Silbermöwe, *Larus argentatus argentatus* Pont. *Ardea*, 17:112–149.

Rand, A. L.
1956 Foot-stirring as a feeding method of Wood Ibis and other birds. *Amer. Mid. Nat.*, 55:96–100.

Sprunt, A., Jr.
1936 An unusual feeding habit of the Snowy Heron. *Auk*, 53:203.

Tinbergen, N.
1953 The Herring Gull's world. Collins, London.

White, S. R.
1946 Notes on the bird life of Australia's heaviest rainfall region. *Emu*, 46:81–122.

Hathaway School of Conservation Education, Massachusetts Audubon Society, Drumlin Farm, South Lincoln, Massachusetts, November 5, 1958

DISPLAY BEHAVIOR OF BUFFLEHEAD, SCOTERS AND GOLDENEYES AT COPULATION

BY M. T. MYRES

THE displays which occur in connection with the mating act have been described in but a few species of birds, and in fewer still has any attempt been made to relate these to, or distinguish them from, the other courtship displays. In a recent study (Myres, M. T., 1957 MS. An introduction to the behaviour of the goldeneyes: *Bucephala islandica* and *B. clangula*. M.A. Thesis, University of British Columbia) it was shown that the pre- and post-copulatory displays of Barrow's Goldeneye were almost indistinguishable from those of the Common Goldeneye. This was in marked contrast to those courtship displays which have a primarily pair-forming and pair-maintaining function, which were remarkably different in the two species. It is therefore of considerable interest to make further comparisons in the displays connected with copulation between other species of sea ducks (tribe Mergini* of the family Anatidae). Such a comparison is presented here between the only other member of the genus *Bucephala* (*B. albeola*, the Bufflehead) and the two species of goldeneye already mentioned, and between two species of the genus *Melanitta* (*M. deglandi*, the White-winged Scoter, and *M. perspicillata*, the Surf Scoter) and the Bufflehead.

During the summer of 1957 I observed copulation of the Bufflehead on 12 occasions on Watson Lake, at 105 Mile, Cariboo Highway, in the Cariboo District of British Columbia. To my knowledge, the actions occurring at copulation have not been described previously for this species. On 103 Mile Lake, two miles away, I observed five instances of copulation in the White-winged Scoter. During the following winter, 1957–58, I saw copulation of the Surf Scoter on four occasions on salt water off Saltspring Island, B. C. The displays observed will be described for each species below, but a few remarks should be made regarding the manner of presentation.

Capitalized words are names allotted to distinct displays. In a few instances names are given to displays, described elsewhere, of other species. To prevent unintended homologization of displays between species, different names are employed wherever possible, except when it is believed that two displays are without any doubt homologous. It will become clear in the course of the discussion which displays, of the species described here, I believe to have had common origins. There may be instances where a name has been used, unavoidably, which is also used for a display in another species not discussed here. In such instances no homology should be understood, unless it has been clearly mentioned.

* Classification follows P. Scott, **Key to the Wildfowl of the World.** Severn Wildfowl Trust, Slimbridge, Gloucestershire, England. Revised, 1951.

In a few places it is stated that one display is more, or less, common than another. Because the number of separate copulations observed is only 21, and only one or two of these were recorded quantitatively by describing them onto magnetic tape, these assertions are not strictly objective. Rather they are subjective impressions received while watching the copulation sequence, in particular the course of the pre-copulatory display behavior.

Bufflehead

Copulation was observed 12 times between May 31 and June 16, 1957, as follows: May 31 (twice), June 1, 2, 3, 4 (three times), 5 (twice), 14 and 16. Most frequently the performance took place between 8:00 a.m. and midday, but on three of the 12 occasions it was seen in the evening. By June 16 many broods of downies were already on the lake, and I estimated that about half the broods subsequently present were there by that date. It is evident, for this and other reasons, that the females with whom males were seen to copulate were already well ahead with the incubation of their clutches by the first day in June.

The female assumes a flattened pose on the water (Prone-posture), but it is unusual for the female to assume this for more than a few moments before the male mounts (this is in contrast to the two goldeneyes where the female may remain in the Prone-posture for as long as 20 minutes).

The male swims around the female, or rests close by her on the water, performing the two main pre-copulatory displays. These are (1) a twitching of the water with his bill (Water-twitch), and (2) a preening movement over his back (Preen-dorsally):

1. The Water-twitch consists of dipping the bill to the water and then a slight sideways movement of the head, which is almost indistinguishable from a similar comfort movement. The movements may be distinctly separated by a pause, or by a Preen-dorsally, or they may be repeated one after the other in fairly quick succession.

2. In the Preen-dorsally it is impossible to be certain that the wing has been lifted in any way on some occasions, and indeed it probably is not lifted on all occasions. The bill must then come into contact with the feathers of the back or the upper side of the folded wing. On other occasions the wing is seen to be only slightly raised, and on one occasion the long scapulars were seen to be lifted more than the carpal joint so that a tiny spot of white appeared (from the secondary feathers or coverts). More often, however, the movement of the wing was just the lifting of a black shape above the back. In the Preen-dorsally the head may be swung around through an arc on the side toward the female, or on the side away from her. It seems likely that the indefinite lifting of the wing, and the variability as to which wing is concerned, may be an indication that the display is not as ritualized as in the surface-feeding ducks in which the colored speculum is flashed during this display—presumably most often in the wing which faces the female. K. Lorenz (1941. *Jour. f. Ornithol.*, 89:194–294) states that in *Aix galericulata* this is invariably so in the Mock-preening display.

In the Bufflehead the Preen-dorsally is closely linked with the Water-twitch, and the latter generally occurs before the former, just as a bird performing

comfort-preening frequently dips his bill into the water in front of him. Undoubtedly the two displays originate from this comfort movement sequence. In the Bufflehead it was observed, however, that Water-twitching was more frequent than the Preen-dorsally (contrast White-winged Scoter).

The unritualized form of these displays is also indicated by the fact that in the goldeneyes the supposed homologues of these movements (Jabbing and Wing-preen) are very highly ritualized: the Jabbing or Water-flicking of the goldeneyes is a frenzied series of movements and the Wing-preen is brief and momentary. Also in the goldeneyes they occur in a fixed sequence leading into the motor pattern of mounting itself—the Wing-preen never occurs, in fact, except as a preliminary motion at the beginning of the Steaming movement which, in goldeneyes, brings the male onto the back of the female.

After a few moments, or a minute or two, of Water-twitch and Preen-dorsally display activity (the frequency of repetition is variable), the male suddenly moves toward the female and mounts. Generally he begins to move toward her from only a foot or so away, and the locomotory performance is not spectacular, but on one occasion it seemed that he made a slight rush over the water. On three occasions, out of eight in which the complete copulation sequence was observed, the wings were momentarily lifted off the back (Wing-flick) and snapped back into place about the time of intromission. This action has also been observed in goldeneyes and scoters. The tail is waggled from side to side during copulation.

On dismounting the male continues to hold onto the head of the female with his bill, and the male and female rotate around each other for one or two full turns (Rotations). On three occasions, out of the 12, it appeared that the female was almost turned over onto her back as the male pulled at her head during the Rotations, and one of her legs was seen thrashing above the water behind her.

As soon as he releases the female, the male almost at once begins to dip his head and the forepart of his body below the water, and to shimmer his wings in the water, as in normal comfort bathing (Bathing). The female also acts similarly, and then both birds stretch upward out of the water (Upward-stretch) and flap their wings (Wing-flap), in a fashion identical with the comfort movements. However, this was only seen to occur on four of the 12 occasions. Twice the male made a shallow plunge below the surface first, as if the movement were an exaggeration of the first dip of the Bathing behavior. On no less than six occasions the male dived deeply (Plunge) coming up from one to 15 feet away from the point of diving. On four of these last occasions the male performed the Upward-stretch and Wing-flap immediately on surfacing without prior Bathing, in another instance he performed Bathing, and in the sixth his actions were not recorded. On one of these six occasions the Upward-stretch and Wing-flap were followed by more Bathing. In two of the

12 instances the female, after she had performed some comfort movements at the end of copulation, performed a few of the neck-stretching and crouching movements which she generally performs when following a particular male away from a strange male or males (Following).

On two occasions the first attempt at mounting did not result in a successful ejaculation, because the male slipped off the back of the female and performed Water-twitching movements again before mounting again. In one of these cases three attempts were made to mount in succession, and in another case the male appeared to give three Water-twitching movements, followed by a single Preen-dorsally, while actually mounted on the back of the female. No Rotations were observed, nor did the male Plunge, after this but he did perform Bathing. The absence of the customary Rotations probably indicates failure to effect ejaculation, because in an unsuccessful copulation in *Bucephala islandica* the post-copulatory Rotations and Steaming displays were absent and the failure was followed by more pre-copulatory display actions, a successful copulation, and finally the normal post-copulatory displays (Myres, *op. cit.*).

White-winged Scoter

Copulation was observed on five occasions: May 31 (once), June 2 (twice in succession), June 3 and 5 (once each). At this period many of the pairs (of which there were about 15 present on 103 Mile lake), were not, apparently, incubating their eggs. They may also have been nonbreeding birds.

The female assumes the Prone-posture from a position in which the head is elevated and forward, as in the "alarm" posture of this species. However, the Prone-posture is assumed only just before the male mounts. On three of the five occasions on which copulation was observed the female suddenly stretched her neck rigidly upward at an angle of 45 degrees forward as soon as the male caught hold of her head feathers on mounting. The same posture was observed when the female reappeared above the water after copulation.

Three displays were observed in the male prior to copulation: (1) False-drinking, (2) Water-twitch, and (3) a Preen-behind-the-wing display (which is presumably the homologue of Preen-dorsally in Buffleheads). It should be mentioned here that during the winter of 1957–58 courtship behavior of this species was watched on a number of occasions. The main elements were the same as in the pre-copulatory behavior (namely the three displays mentioned above). This is the *only* species, of the ones reviewed here, in which this equivalence has been found. In the goldeneyes, Bufflehead and Surf Scoter the courtship displays of the pair-forming and pair-maintaining series differ quite markedly from the pre-copulatory displays.

1. False-drinking was performed by the male alone, or mutually by both male and female when it may be repeated a number of times. The display consists of dipping the bill to the water in front of the bird and a sudden elastic elongation of the neck forward and upward at an angle of about 75–80 degrees, until it is fully stretched and the head and neck appear to be larger than the rest of the body. The neck relaxes and shortens, more slowly, immediately afterward. In the final stages of the pre-copulatory behavior, the False-drinking display may sometimes be less common than it is in the courtship behavior, this

was not consistently the case.

2. The Water-twitch was a dipping of the bill to the water, but with only a slight shake of the head. Generally the head was immediately lifted and swung round to the side, through 170 degrees, to the middle of the back and the Preen-behind-the-wing took place. The Preen-behind-the-wing was sometimes more common than the Water-twitch (contrast Bufflehead), but whenever the Water-twitch occurred it appeared always to be followed by a Preen-behind-the-wing.

3. The Preen-behind-the-wing takes three forms: (a) the scapulars and secondaries are lifted and held up for some movements which also exposes the white speculum, distinctive of this scoter. The preening movement may take place with the wing on the side toward the female, or on the side away from her. It often occurs when the male is some distance from the female; (b) the bill is thrust along the side of the body, or into the shoulder feathers, and the pink bill is then clearly visible against the black body plumage as the preening movement is made; and (c) the back feathers are nibbled. The white iris and white feathers around the eye are also most striking in both (b) and (c).

Eventually the male mounts the female, but there is a considerable period between the time the male covers the female and the Wing-flick. This movement was observed to occur once (or twice) in all five of the copulations observed. It was a vigorous movement, and made a sound as the wings beat the water. Upon dismounting, on two occasions the male was just holding on to the head of the female, but only a fraction of a circle (perhaps 20–30 degrees) was rotated. There was no post-copulatory display (contrast Surf Scoter), except that the male (upon slipping back into the water) flicked the tips of the primaries to rearrange the wings. The male was then in a hunched posture and drifted or swam slowly away from the female. The female also rearranged her wings.

Surf Scoter

Copulation was observed on four occasions in midwinter on the sea off Saltspring Island, B. C.: December 29, 1957 (once), January 3, 1958 (twice in midafternoon) and January 5, 1958 (once in the afternoon). On all occasions there is no evidence to indicate that the birds involved were permanently paired. It would appear, by comparison with copulations of the White-winged Scoter observed on the breeding grounds, that the complete copulation display sequence was observed, despite the time of year.

The Prone-posture resembles that of the goldeneye. The female lies flat with the neck below the water, and the bill curved upward. The longest time this was held was about two minutes in one of the copulations.

The displays involved were extremely similar to those observed at copulation of the White-winged Scoter. The main pre-copulatory displays were the Water-twitch and the Preen-behind-the-wing, though these were not described in detail, while False-drinking was also observed.

The male mounted the female slowly, as in the White-winged Scoter, and in every case the wings were eventually flicked, but the movement was a single Wing-flick, not a double one. Upon dismounting, however, there was

a display not observed in the White-winged Scoter. This display (Chest-lifting) was seen on all four occasions as follows:

As soon as the male slipped back into the water he threw his head back until it was over the middle of his back, which developed a 45 degree slope, and he thrust out his chest. Chest-lifting greatly resembles a display which is seen in a courting party. It is a sudden and brief movement. After Chest-lifting, no other movements by the male were observed. In one case the female did some unidentified movements afterwards, and then did the Upward-stretch and Wing-flap.

There were unusual features about two of the copulations observed: (a) the third copulation occurred only a few minutes after the second, though it is not certain that the same male was involved in each case. The time was around 3:00 p.m. It was very mild, and drizzling at the time. A small party of Surf Scoters broke up, leaving two females and a male. The two females were tilting their bills upward repeatedly without lifting their heads, as in the Chin-lifting of Lesser Scaup (*Aythya affinis*). The male, between them, was performing the display in which he lifts the head and makes a scooping movement across the chest. The male also performed Water-twitches and Preens-behind-the-wing. Then he did some violent dipping, of the Bathing sequence, and one of the females assumed the Prone-posture. The male mounted her and copulation proceeded although the other female was almost touching them. (b) In the fourth and last copulation, the male mounted the female from in front, over her head. She quickly swung around beneath him, but there was (as usual) a considerable pause before he seized her head feathers.

Discussion

The displays occurring in the copulation sequence of the two genera *Bucephala* and *Melanitta* are listed and compared in Table 1. The pre-copulatory displays of the male Bufflehead consist of twitching the water with the bill, and making a preening-type movement in the dorsal region between the wings. Similar displays occur in the two scoters studied. In the two goldeneyes, by contrast, the predominant pre-copulatory displays of the male are stretching the wing and leg, and flipping water into the air with the bill. As I was more familiar with the goldeneyes I was not at first sensitive to the fact that Water-twitches and Preening-dorsally were indicative of copulation behavior in the Bufflehead.

It seems to be significant that in Buffleheads the Water-twitch movement may be more frequent than the dorsal preening movement, whereas in the White-winged Scoter the preening movement is the more frequent pre-copulatory display. Whenever the Water-twitch did occur in the scoter it was generally followed immediately by a Preen-behind-the-wing. The twitching of the water with the bill before preening is, of course, a normal part of a comfort movement sequence in diving ducks, and it is most interesting that *M. deglandi* and *B. albeola* have diverged in the relative frequency with which they use these two movements in display. I find that Lorenz (*op. cit.*) also noted instances of variously ritualized linkages of two displays of the general courtship sequence

in some other ducks. In the Wood Duck (*Aix sponsa*) and the Mandarin Duck (*Aix galericulata*) of the tribe Cairinini, for example, the Mock-preening display never occurs without the preceding "drinking" movement. In the Wood Duck "drinking" may occur at lower intensity by itself, but in the Mandarin Duck the two displays are absolutely linked. In the Gadwall (*Anas strepera*) Lorenz found, furthermore, that the two displays are equally firmly linked. but in the reverse order (Mock-preening is followed by "drinking").

TABLE 1

DISTRIBUTION OF MALE COPULATORY DISPLAYS IN *MELANITTA* AND *BUCEPHALA*[1]

	M. perspicillata	M. deglandi	B. albeola	B. islandica B. clangula
Pre-copulatory				
	False-drinking	False-drinking	———	**Water-flip**[2]
	———	———	———	**Wing- and Leg-stretch**
	Water-twitch	Water-twitch	**Water-twitch**	Note[2]
	Preen-behind-wing	**Preen-behind-wing**	Preen-dorsally[2]	Note[2]
Mounting				
	———	———	———	Water-flick (and Jabbing)[2]
	———	———	———	Wing-preen[2]
	———	———	———	Steaming
	Single Wing-flick	Double Wing-flick	Wing-flick(?)	Wing-flick
Post-copulatory				
	———	———	Rotations	Rotations
	Chest-lifting	———	———	Steaming
	———	———	Plunge or Bathing	Bathing
	?	Rearrangement-of-wings[3]	Upward-stretch and Wing-flap[3]	Upward-stretch and Wing-flap[3]

[1] The displays in boldface are the mast frequent displays in each species.
[2] It shauld not be taken as certain that any of these displays are homolagaus until analytical ethalagical wark has been canducted, but in the discussian it has been assumed that Water-twitch, Water-flick and Jabbing may be the same; that False-drinking and Water-flip are the same; and that Preen-behind-the-wing, Preen-darsally and Wing-preen are the same.
[3] Generally this is fallawed by a Tail-wag, but this was nat specifically noted in these displays, thaugh it probably accurred. The Rearrangement-of-wings af **M. deglandi** may represent the settling af the wings after the Wing-flap which generally caincides with the Tail-wag.

Preen-dorsally, or Preen-behind-the-wing, may well be homologous with the Mock-preening movements found in the general courtship displays of *Aix* and *Anas*, in which a colored speculum has been evolved, which emphasizes this ("morphological reinforcement"). and other movements (Lorenz. *op. cit.*; Tinbergen, N., 1952. *Quart. Rev. Biol.* 27: 24 and 27). In *Anas discors*, *A. cyanoptera*, *A. querquedula* and *A. clypeata* there is a further development. The secondary coverts are pale blue, and Lorenz (*op. cit.*) states that in *A. querquedula* the preening movement takes place on the outside (instead of the inside) of the wing, and that the bill is actually directed at these coverts

rather than the speculum. In only one of the three scoters are the secondaries differentiated and at variance in color from the rest of the black plumage of the wing. But display-preening is not absent in the two scoters studied merely because of this. Instead of plumage differentiation we find that the scoters have brightly colored bills (bright pink; white, orange and black; pale yellow or orange). It seems certain that the colored bill must be an alternative method of emphasizing the display movement. It really matters very little, so far as producing additional sign stimulation is concerned, whether this is done by preening *specula* (or *coverts*) which are colored, or by a *bill* (colored) preening a uniformly dull wing.

The Water-twitch of the Bufflehead is probably homologous with the Jabbing display of *B. clangula* or the Water-flicking behavior of *B. islandica* (Myres, *op. cit.*) which also occur in the pre-copulatory sequences. Jabbing in *B. clangula* immediately precedes the momentary Wing-preen display before mounting. But the Water-twitching movement of *B. albeola* was never a group of frenzied Jabbings as it is in *B. clangula*. The Wing-preen display of the goldeneyes is very rapid and, as a display, occurs only in the pre-coition sequence: in *B. clangula* it is a single momentary movement just as the pre-coition Steaming posture is assumed. In the Bufflehead and White-winged Scoter the movement is not unusually rapid, and so appears less ritualized. No False-drinking, Wing- or Leg-stretching, or Steaming movements were observed in the pre-copulatory behavior of the Bufflehead. But False-drinking (comparable to Water-flip of the goldeneyes) occurs in the pre-copulatory display of the White-winged Scoter, though rather less frequently than the Preen-behind-the-wing or the Water-twitch.

The post-copulatory displays are also interesting. Rotations do not occur in the White-winged or Surf Scoters at all. In the two goldeneyes they do not appear to differ at all from the Rotatory movements of Buffleheads. It is not clear to me yet which of the two sexes is providing the propulsive thrust, and which the drag, which results in circling of both birds over one spot.

The pre-and post-copulatory Steaming displays of the two goldeneyes appear to be completely absent from *B. albeola* and the two scoters. In the Bufflehead a deep dive (Plunge) occurs on some occasions, which would appear to be an exaggeration of the preliminary plunges or dips which accompany Bathing. Bathing always occurs after copulation in the two goldeneyes, as well as in the Bufflehead, but in the latter species was omitted when the Plunge occurred. The Plunge was followed directly by the Upward-stretch and Wing-flap. Bathing and even the Upward-stretch and Wing-flap were absent in the post-copulatory sequence of the two scoters, and the only comfort action was a flicking of the tips of the primaries (Rearrangement-of-wings), which is possibly homologous with the final motions of closing the wings after the Wing-flap which completes the sequence in *Bucephala*. The only way in

which the Surf Scoter differs in copulatory behavior, qualitatively, from the White-winged Scoter is in having a distinct post-copulatory display (Chest-lifting).

Whereas in the goldeneyes the female may be in the Prone-posture for a considerable time (as long as 20 minutes), in the Bufflehead and Surf Scoter the Prone-posture is assumed only a short while before the male mounts, and in the White-winged Scoter was observed only immediately prior to mounting, or as the male trod the female. There may be a correlation between the duration of soliciting by the female and the number and variety of displays in the male, e.g., the most are found in the long-soliciting goldeneyes, and the fewest in the White-winged Scoter. In the Bufflehead there were a few suggestions that, while mounted, the wings of the male were flicked. In goldeneyes the Wing-flick is a regular accompaniment of intromission. In all five instances of copulation in the White-winged Scoter a double Wing-flick was noted, and in all four instances a single Wing-flick was seen in the Surf Scoter.

A major theoretical interest of the pre- and post-copulatory behavior of the ducks under discussion is that the displays involved are generally confined to the moments just before, and just after, the act of mating. They are generally confined to this moment in the reproductive cycle, and are rare in the more frequently described courtship behavior. Thus the Head-bobbing of the Bufflehead, which is the most well-known display of the male of that species, is absent completely from the copulation sequence. This rule applies fairly well also in the two goldeneyes. The Headthrow of *B. clangula* and Rotary-pumping of *B. islandica*, which are respectively the most frequently observed displays of these species, occur infrequently in the pre-copulatory behavior. In *B. islandica* it is possible to watch the Rotary-pumping display give way as the time for coitus approaches, to Water-flips and the Wing- and Leg-stretching displays indicative, in the male, of copulation.

Ethologists are asked to realize the importance of the displays associated with copulation. These displays prove to be, in ducks, more conservative than the general courtship displays with pair-forming and pair-maintaining function. The copulation sequence may thus be of considerable importance in studies of the taxonomic relationships of species and genera. Thus, taking all displays into account, it is very hard to place the Bufflehead in the family tree, but considering only the displays of the copulation sequence it appears to be intermediate between the scoters and the goldeneyes. A much clearer picture will be established when descriptions of coitus are available for the other ducks comprising the tribe Mergini.

Another interest of the displays occurring at copulation lies in the light they may throw on the *successive* evolution of courtship displays within a differentiating stock of animals. In the present case the developmental status of the Jabbing and Wing-preen displays of the Common Goldeneye, on the one hand,

and the Mock-preening of *Anas* and *Aix* on the other, appears uncertain. The Water-twitch and Preen-dorsally, or Preen-behind-the-wing, displays appear less ritualized than either, but the direction in which evolution may have proceeded in regard to these displays is not yet clear. A comparative review of the evolution of courtship *versus* the copulation displays is planned.

Acknowledgments

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Summary

The copulation of *Bucephala albeola* was observed 12 times, of *Melanitta deglandi* five times, and of *M. perspicillata* four times. The displays and actions employed are compared with those occurring at copulation in the two goldeneyes (*Bucephala* spp.). The Wing- and Leg-stretch display of the latter was completely absent from *B. albeola* and *M. deglandi*, in which the Water-twitch and the Preen-behind-the-wing predominated. Both these movements occur in association, however, in the normal comfort-preening sequence of ducks, and in similar (? non-homologous) Mock-preening displays in the general courtship displays of members of both the Anatini and Cairinini. In the copulation behavior of goldeneyes they occur only in a momentary form just immediately prior to the exaggerated Steaming display which constitutes the approach to the female at mounting in these species. The post-copulatory Rotations, alone of all the displays, take exactly the same form in all three species of *Bucephala*. Rotations were not observed in scoters and the only difference between the two scoters in the displays occurring at copulation was in the existence of a Chest-lifting display after coitus in the Surf Scoter. The post-copulatory Steaming of the goldeneyes is replaced in *B. albeola* by a Plunge movement on some occasions. This may be an exaggerated prelude to the bathing that occurs after coitus. Scoters lack Steaming displays and the White-winged Scoter merely rearranges the wings after dismounting.

Ethologists, it is suggested, should pay more attention to the comparative aspects of copulation displays, since they are probably conservative. Taken with other differences in display between *B. albeola* and the goldeneyes, the possibility exists that *B. albeola* should not be placed in the same genus as the goldeneyes. The evolution of morphological reinforcement of the sign stimulatory effects of motor patterns of display is discussed in reference to the speculum of ducks in general, and to the colored bills of scoters in particular.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, BRITISH COLUMBIA, FEBRUARY 8, 1958

FOOD HABITS OF NESTING COOPER'S HAWKS AND GOSHAWKS IN NEW YORK AND PENNSYLVANIA

BY HEINZ MENG

MUCH has been written about the food habits of our birds of prey. Through crop and stomach content analyses it has been shown that most hawks and owls are beneficial to man's interests and, therefore, are protected by many states. However, there is a notable exception—the accipiters. In only eight states are the accipiters fully protected. Five other states protect them except when they do damage to poultry, livestock, etc. Food habit studies always indicate that the large accipiters—the Cooper's Hawk (*Accipiter cooperii*) and the Goshawk (*Accipiter gentilis*)—feed largely on poultry and game and, therefore, are unprotected.

Accipiters are exceedingly wary, woods hawks and are seldom seen even in areas where they are abundant. Cooper's Hawks and Goshawks are fast fliers and are seldom shot by hunters. The great majority of specimens available for food habit studies, therefore, come from game farms where they are caught in pole traps. Most of these hawks are young birds which have been attracted by the concentrations of game or poultry. Occasionally accipiters (as well as buteos) are shot from "kills" which prove to have been previously crippled or wounded game birds (McDowell and Luttringer, 1948). Analyses of the crop and stomach contents of this rather select group of hawks will naturally indicate a high percentage of poultry and game birds in their diet.

Probably the best way to secure information about these hawks is to study their feeding habits during the nesting season. Nests are located early in the spring and studied throughout the breeding season. For the past ten years I have studied the food habits of nesting Cooper's Hawks and Goshawks in New York and Pennsylvania. Pellets and remains of prey found in the nests and nest areas were collected and analyzed. Data were secured from 34 Cooper's Hawk nests and 14 Goshawk nests.

During the first three years of this period (1948–1950) a study was made of the food consumed by 12 broods of Cooper's Hawks. Each nest was visited four or five times a day from the hatching date until the hawks had left the nests. All of the pellets and remains of prey were collected and analyzed. Pellets found during one day were combined with the data of quarries observed in the nest on the previous day, in order to determine not only what species were preyed upon but also how many of each. Table 1 shows the kind and number of food items consumed by 42 young Cooper's Hawks at 12 nests in the Ithaca, N.Y., region.

In the Ithaca region the food of growing Cooper's Hawks, as well as of the adults who partake of the prey brought to the young, consists of 18 per cent mammals and 82 per cent birds. The most important prey mammals are the

TABLE 1

FOOD OF YOUNG COOPER'S HAWKS AT ITHACA, NEW YORK

Species		Number
Birds		
Ring-necked Pheasant (*Phasianus colchicus*)		4
Spotted Sandpiper (*Actitis macularia*)		1
Rock Dove (*Columba livia*)		13
Mourning Dove (*Zenaidura macroura*)		5
Screech Owl (*Otus asio*)		1
Yellow-shafted Flicker (*Colaptes auratus*)		134
Pileated Woodpecker (*Dryocopus pileatus*)		1
Red-headed Woodpecker (*Melanerpes erythrocephalus*)		1
Yellow-bellied Sapsucker (*Sphyrapicus varius*)		1
Hairy Woodpecker (*Dendrocopos villosus*)		5
Blue Jay (*Cyanocitta cristata*)		11
Catbird (*Dumetella carolinensis*)		1
Robin (*Turdus migratorius*)		79
Wood Thrush (*Hylocichla mustelina*)		7
Starling (*Sturnus vulgaris*)		241
Ovenbird (*Seiurus aurocapillus*)		5
Bobolink (*Dolichonyx oryzivorus*)		1
Eastern Meadowlark (*Sturnella magna*)		118
Redwinged Blackbird (*Agelaius phoeniceus*)		3
Common Grackle (*Quiscalus quiscula*)		37
Brown-headed Cowbird (*Molothrus ater*)		17
Scarlet Tanager (*Piranga olivacea*)		9
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)		1
Rufous-sided Towhee (*Pipilo erythrophthalmus*)		2
TOTALS	24	698
Mammals		
Cottontail (*Sylvilagus floridanus*)		6
Eastern Chipmunk (*Tamias striatus*)		109
Gray Squirrel (*Sciurus carolinensis*)		4
Red Squirrel (*Tamiasciurus hudsonicus*)		36
TOTALS	4	155
TOTALS	28	853

chipmunk and the red squirrel, which together make up 94 per cent of the mammalian diet during the nesting season. The Starling, Yellow-shafted Flicker, E. Meadowlark, Robin, and Common Grackle together constitute 87 per cent of the avian diet, with the Starling being by far the most frequent item on the menu.

L. L. Snyder (1937) examined 40 Cooper's Hawks killed in Ontario during 1931 and 1932 and found Starlings in 17 of them.

In a typical nest containing four young, an average of 266 prey items was brought to the nest during the first six weeks: 4 quarries per day during the first week, 5 per day during the second week, 7 per day throughout the third week, 9 per day during the fourth week, 7 each day during the fifth week and 6 per day in the sixth week. It takes an average of 66 prey items to raise a Cooper's hawk to the age of six weeks. The females are about one-third larger than the males and require more food, so this figure would be slightly higher for the females and lower for the males.

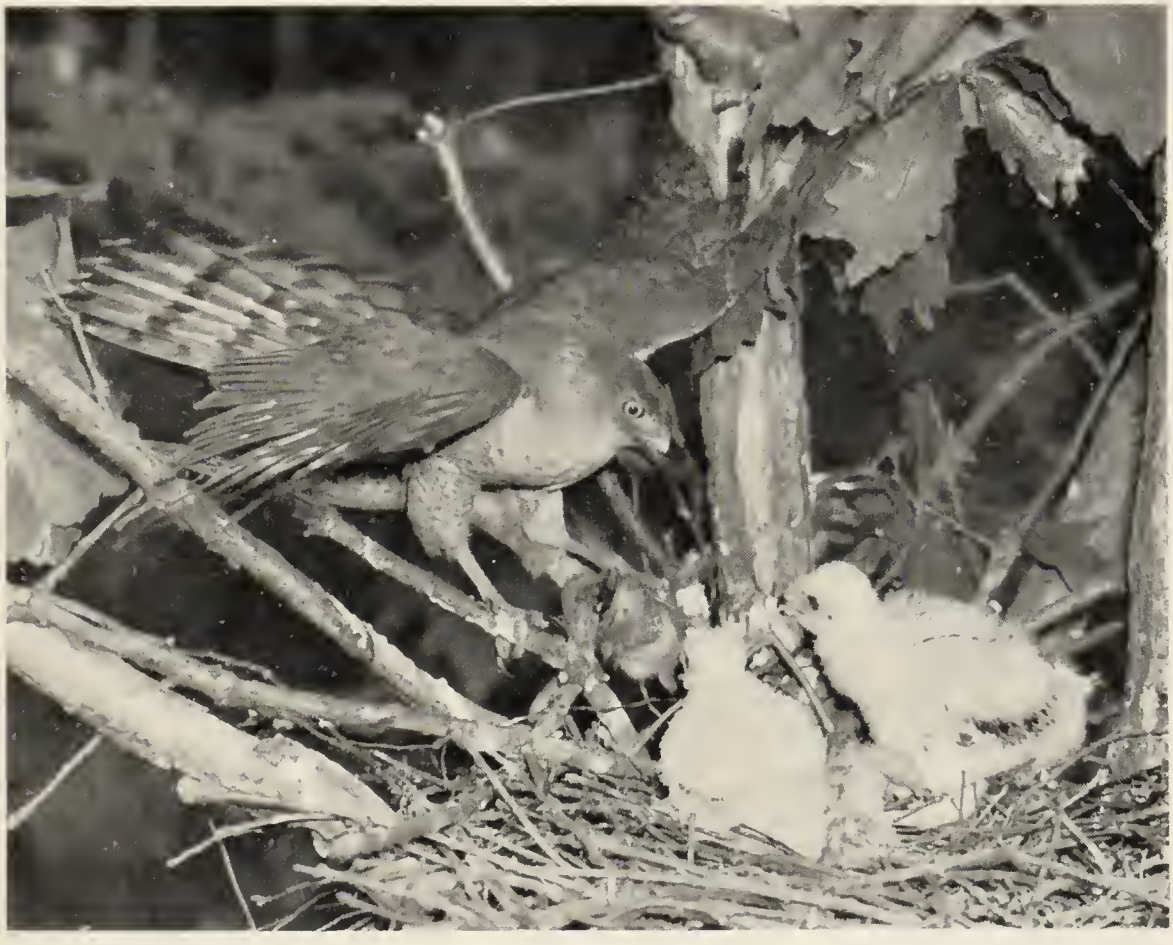


FIG. 1. Cooper's Hawk at nest with young.

Most quarries are young animals that have not yet learned to be sufficiently wary, but occasionally adult birds are also brought in. These are probably caught while protecting their young. Like most predators the Cooper's Hawk will take what is most abundant and easiest to catch. Sometimes even two-thirds-grown nestling birds are taken from their nests. On two occasions I saw a male, who does almost all of the hunting, bring two live nestling Scarlet Tanagers to its nest.

There have been a few reports of Cooper's Hawks taking young chickens during the nesting season, and if an individual male gets into this habit he may cause quite a loss to the owner. However, very few acquire this habit and most hawks tend to specialize on common wild birds or mammals that are available throughout the year. One Cooper's Hawk nest that was studied intensively was within 300 yards of a large poultry range. Thousands of chickens could be seen from the nest, and they were sufficiently small so that the male could have easily killed and brought them to the nest, but not a single one was found in the nest, nor did the owner complain of having lost any. A similar incident in the case of a Goshawk nest in Nova Scotia was reported by A. C. Bent (1937:132–133). The nest was located one-half mile from a poultry yard that produced about 300 chicks. The farmers did not complain of losing a single bird all summer, nor had they seen any "hen hawks" about their premises.

Time did not permit as intensive a study of the 14 Goshawk nests, but some rather interesting data were gathered. Nine of the nests were located in Wayne Co., Pa., three in Potter Co., Pa., and two in Chenango Co., N.Y. Each of the nests was visited several times during the nesting season, and once about a month after the young had left the nest. Pellets and remains of prey were gathered and analyzed (Table 2).

TABLE 2

ANALYSIS OF PELLETS AND PREY REMAINS AT GOSHAWK NESTS

Species		Number of times found
Birds		
Sparrow Hawk (*Falco sparverius*)		3
Ruffed Grouse (*Bonasa umbellus*)		5
Blue Jay (*Cyanocitta cristata*)		7
Common Crow (*Corvus brachyrhyuchos*)		83
Blackbird (*Euphagus, Quiscalus, Agelaius*)		15
TOTALS	7	113
Mammals		
Cottontail (*Sylvilagus* sp.)		7
Eastern Chipmunk (*Tamias striatus*)		3
Gray Squirrel (*Sciurus carolineusis*)		4
Red Squirrel (*Tamiasciurus hudsonicus*)		58
TOTALS	4	72
TOTALS	11	185

As can be seen from Table 2 the red squirrel and the Common Crow were the main food items of these 14 nesting pairs of Goshawks. Under one nest 24 crow legs and 15 humeri were found, and at another nest 3 crows were brought to the young while the writer was photographing the hawks from a blind. The remains of grouse were found only five times. The wing and leg bones of large birds are generally not swallowed by the hawks, and they can be found under the nests and in the nest areas. The humeri of crows and grouse are very similar in appearance, and very probably crow humeri have been mistaken for grouse bones in the past. In the area studied, crow humeri average 64 mm. in length and are straighter than grouse humeri, which average 57 mm. in length.

Fig. 2. Goshawk at nest with young.

In all of the Goshawk nest areas studied the grouse population was high, but grouse appeared only five times in contrast to 83 crows. This suggests that the Goshawks do not select a particular area to nest in because of the high grouse population, as is often thought, but that they may even be instrumental in increasing the numbers of grouse by removing numerous crows. Red squirrels, chipmunks, and crows destroy many grouse nests by feeding

on the eggs and young, or, as in the case of the chipmunk, by pushing the eggs out of the nests.

From the above data it can be seen that the Cooper's Hawk and Goshawk are important predators of the Starling. Common Crow, red squirrel, and chipmunk. In view of these data it seems logical that these two accipiters should be protected along with the other birds of prey. Also, as long as even one species of hawk or owl remains unprotected all will continue to be shot. I feel that all birds of prey should be given protection, with the stipulation, as is found in Michigan's law, that "a farmer or landowner may destroy hawks or owls on the land which he owns or occupies, which are doing real damage to poultry or other domestic animals" (Morrison, 1955).

Literature Cited

Bent, A. C.
1937 Life histories of North American birds of prey. *U.S. Nat. Mus. Bull.* 167.
McDowell, R. D., and L. A. Luttringer
1948 Pennsylvania birds of prey. Pennsylvania Game Commission. 33 pp.
Morrison, K. D.
1955 Bird protection laws show progress. *Audubon Mag.*, 57:224.
Snyder, L. L.
1937 The Starling in Ontario. *Roy. Ontario Mus. Zool. Leaflet* no. 4.

State University Teachers College, New Paltz, New York, December 16, 1958

NOTES ON THE NESTING OF *TURDUS LEUCOMELAS* IN SURINAM

BY F. HAVERSCHMIDT

The Grey-headed Thrush (*Turdus leucomelas*) has a vast range in South America from Colombia eastward to the Guianas and southward to southeastern Brazil, Matto Grosso and Perú. The representative in Surinam, *T. l. albiventer*, is confined to Colombia, Venezuela and the region from the Guianas southward to the middle Amazon and Bahia. The upper surface of this thrush is brown, except the head which is dark greyish. The breast, abdomen and sides of the body are grey, the throat being broadly streaked with white. The axillaries and under wing coverts are bright rufous and the eyes are dark red. The sexes are indistinguishable in the field. The weights of specimens collected by me in Surinam are: 10 males, 55 to 76 grams (mean, 68), and 5 females, 67 to 75 grams (mean, 71).

In the coastal region of Surinam this is the commonest thrush, frequenting open forests and coffee plantations. It is now a common garden bird, breeding even in the middle of Paramaribo, but it also occurs in the sandy savannas further into the interior wherever there are scattered bushes or patches of forest. The local name in Surinam is "boontjedief" (= thief of peas). Another thrush in the coastal and savanna area is *Turdus nudigenis* which is found in the same habitat but it is definitely less numerous. Two other species, *T. fumigatus* and *T. albicollis*, are shy forest birds.

Breeding season.—In the Penard Oölogical Collection from Surinam, now preserved in the Leyden Museum, the eggs of *T. leucomelas* are dated January to June, but in my experience the breeding season begins at least two months earlier, in November and December. Thus, nesting seems to be confined to the short rainy season (from mid-November until mid-February), the short dry season (from mid-February until mid-April) and the long rainy season (from mid-April until mid-August). Breeding apparently does not take place in the driest months of the year (August to October) which may be due to the fact that at that time the ground is too hard and dry to provide sufficient food for the nestlings. That breeding does take place in the short dry season is not a contradiction of this rule since there is quite a lot of rain in this period, in most years. In fact, during the last several years this season was extremely wet. Fifteen nests in which incubation was in progress were distributed as follows: November, 1; December, 2; January, 1; February, 1; March, 2; April, 4; May, 4.

From December, 1951, until June, 1952, I was able to observe a pair that nested on a rafter near one of my windows, and which reared four broods in rather quick succession in the same nest. Though the birds were not marked

I am certain that it was the same pair. Their history is as follows:

Brood No. 1. Nest-building started on December 8, 1951. Incubation was seen for the first time on December 18, and feeding the nestlings on January 1, 1952. Two young left the nest on January 16 and one the following day.

Brood No. 2. Repairing of the nest started on January 29. Incubation was seen on February 6, and feeding the nestlings on February 20. Three nestlings left the nest on March 6, 7 and 8, respectively.

Brood No. 3. Repairing of the nest was seen on March 14, and incubation began on March 18. Two young left the nest on April 18 and 19.

Brood No. 4. Repairing of the nest started on April 25. On April 30 it was still empty, but it contained 2 eggs on May 2 and 3 eggs on May 3. The eggs hatched on May 15. Two nestlings left the nest on June 1.

In four broods a total of 10 young was reared.

Nest and nest-building.—In the cultivated area the nest is very often made on rafters under wooden buildings. The nest is a typical thrush nest, and is lined with small, dry roots, therefore resembling the nest of the European Blackbird (*Turdus merula*). I observed only one bird engaged in building, probably the female as is the rule among thrushes.

Eggs.—As most nests are difficult to reach I have no records of clutch size apart from Brood No. 4 (3 eggs), but from the data in the Penard Collection it seems that a 3-egg clutch is the rule, and that 4 eggs may occur. The weights of three fresh and unblown eggs from Brood No. 4 were 6.2, 6.4 and 6.6 grams. In Brood No. 4 the eggs were laid daily.

Incubation.—Invariably I saw only one member of the pair incubating, almost certainly the female, which is also the rule among thrushes. I never observed it being fed on the nest by its mate. The nest in which I observed four broods was on the rafter directly under aluminum plates of a roof on which the sun shone during practically the whole of the day. Under these circumstances the temperature at the nest was extremely high and the incubating bird spent most of the time not sitting in the nest but crouching on it, panting with an open bill.

I was able to determine the incubation period only in Brood No. 4. The last egg was laid on May 3, when incubation started and all three eggs hatched on May 15, an incubation period of 12 days.

On March 25, 1952, when the bird was incubating Brood No. 3, a female Glossy Cowbird (*Molothrus bonariensis*) appeared and inspected the rafter with the nest. Its appearance caused a great tumult among the thrushes which chased it away, both of them dive-bombing the cowbird which disappeared as fast as it could. It was certainly only searching for nests of the House Wren (*Troglodytes musculus*) which is its usual host in Surinam and which regularly nests on rafters in the same situation as the thrushes. Other thrushes often took a bath in the gutter near the nest but when coming too near it they were chased away by both birds of the nest.

The nestling period.—The nestlings were fed by both parents and in practically all cases with unrecognized animal food. Once an unidentified berry

was brought to them. The excreta of the young were always taken away and dropped at some distance. I never saw them being swallowed. In the beginning of the nestling period the nestlings often were covered by the bird which had just fed them. The parent crouched over them exactly as during the incubation period. In Brood No. 4 this was seen for the last time on May 21, the nestlings then being seven days old.

When both parents arrived at the same time with food one of them waited in the neighborhood of the nest until the other had fed the nestlings. I never noted that one of the birds passed the food to the other or that both were at the nest at the same time. One of them—certainly the male—often arrived singing in flight while carrying food in its bill. The same bird often uttered a few strophes after having fed the young. Both parents customarily perched on a piece of wood near the nest before alighting on it, and also after feeding. It was on this perch that I observed on March 5, 1952, (Brood No. 2) an interesting behavior. After having fed the nestlings one of the birds alighted as usual on the piece of wood when suddenly its mate with food in its bill alighted near it. The first one took fright by the sudden appearance of its mate and took a threatening attitude, flashing both wings, a movement by which the rufous axillaries and under wing coverts became very conspicuous. It was exactly the same attitude described and figured by Dilger (1956. *Auk*, 73:324) as "double wing flashing" in *Catharus fuscescens*, but I did not note down whether this thrush tilted one of its feet in this attitude like *fuscescens*.

In only one case (Brood No. 4) was I able to determine the exact fledging period. The nestlings hatched on May 15 and left the nest after 17 days, on June 1. The nestlings having left the nest, were fed for some unknown period, probably by the male only, at least in the latter part of this period, for repairing of the nest for the next breeding cycle started in the same period. In Brood No. 2 the young left the nest on March 6, 7 and 8. Two of them were still being fed on March 15, whereas the repairing of the nest started on March 14.

Bathing.—Grey-headed Thrushes are very fond of bathing either by taking a shower bath in a tropical torrent or the usual bath while standing in a shallow pool of water. Sunbathing is also a regular habit in which the bird lies on its side on the ground with ruffled feathers and widely spread tail and widely open bill, one of its wings stretched to the utmost so that their underside is hit by the direct rays of the sun while it tilts over to the other side.

P.O. BOX 644, PARAMARIBO, SURINAM, DECEMBER 9, 1956

NOTES ON CERTAIN GROUSE OF THE PLEISTOCENE

BY ALEXANDER WETMORE

In the Ozark region of northwestern Arkansas in the spring of 1903, Mr. Waldo Conard, while searching for the site of an old lead mine, found a deposit of bones, some of which were sent to the American Museum of Natural History. Dr. Barnum Brown on behalf of that institution visited the area in the fall of 1903, and again in 1904, securing several hundred specimens. In his report (Brown, 1908) he identified 41 species of mammals, of which he named 19 as extinct species or subspecies new to science. Ten others were identified to genus or species, and in addition there was mention of amphibians, lizards, snakes and various bones of birds. Among the latter he listed the Turkey (*Meleagris gallopavo*) with a query. The location, near the northern boundary of Newton County, was on a hill at 1030 feet elevation, a mile north of the Buffalo River, 4 miles west of the settlement known as Willcockson, and 15 miles south of the town of Harrison in Boone County.

Some of the bird material later came to R. W. Shufeldt, who (1913, pp. 299–301) verified Brown's identification of the fragmentary material of the Turkey, and made additional rambling remarks under three headings, one marked "*Bonasa umbellus*?," and the other two headed "Bird (indetermined)," with reference under each to illustrations from photographs published in accompanying plates. The supposed grouse bones were allocated tentatively, as he stated that he had no skeleton material of the Ruffed Grouse available for comparison. In final comment (*loc. cit.*, p. 300) he said, "If subsequently found to be another species of either *Bonasa* or *Lagopus*, I would suggest the specific name of *ceres*." The records, except for the Turkey, have remained in this uncertain state until now.

Recently John E. Guilday of the Carnegie Museum, through Dr. Kenneth C. Parkes of that institution, has requested assistance in the identification of grouse bones from a Pleistocene deposit in western Pennsylvania. To provide this information it has been desirable to make a firm determination of the earlier Arkansas grouse material, since the bones from Pennsylvania were similar in size. The Arkansas specimens, in the American Museum of Natural History, have been made available to me through the kindness of Dr. Edwin H. Colbert and Mrs. Rachel H. Nichols. Shufeldt's material proves to represent an extinct species of Prairie Chicken, as indicated in the following allocation and discussion.

Tympanuchus ceres (Shufeldt)

Bonasa or *Lagopus* . . . . . *ceres* Shufeldt. Bull. Amer. Mus. Nat. Hist., vol. 32, art. 16, August 4, 1913, p. 300, Pl. 55, figs. 18–20, Pl. 56, figs. 45–72.

Pleistocene (Conard Fissure): Four miles west of Willcockson, and one mile north of Buffalo River, northern Newton County, Arkansas.

Type.—Amer. Mus. of Nat. Hist., Dept. of Vert. Paleo. no. 12392.

Characters.—Generally similar to the modern Lesser Paririe Chicken (*Tympanuchus pallidicinctus* [Ridgway]), but somewhat smaller; bill broader and somewhat stronger, as indicated by a fragmentary premaxilla; coracoid shorter but with shaft equally strong; scapula more slender; wing relatively smaller, as demonstrated by the individual elements as follows: humerus smaller, with head less bulbous, external condyle relatively smaller, entepicondyle slightly shorter, and opening for the pneumatic foramen a little smaller; ulna and radius definitely shorter, indicating a smaller middle segment of the wing; carpometacarpus slightly shorter and somewhat more slender; leg similar in length, but with the individual elements of femur, tibiotarsus and tarsometatarsus somewhat more slender.

Measurements.—Following are pertinent measurements of complete elements of the skeleton, with similar data from two male and two female skeletons of *Tympanuchus pallidicinctus* for comparison. The modern Heath Hen (*Tympanuchus cupido cupido*) and the Greater Prairie Chicken (*Tympanuchus cupido pinnatus* [Brewster]) are decidedly larger.

Total lengths	Tympanuchus ceres	Tympanuchus pallidicinctus
Coracoid	45.2	45.3–48.8
Humerus	59.7–60.5	61.2–67.5
Ulna	55.9–56.3	58.3–65.6
Radius	47.7–50.2	53.2–58.6
Carpometacarpus	33.1–34.7	34.7–41.0
Femur (approximate)	65.0–66.8	62.0–67.0
Tibiotarsus	85.5–87.2	80.3–89.8
Tarsometatarsus	44.9–45.4	42.8–47.2

Remarks.—A part of the sternum comprising the anterior end of the carina is too fragmentary to afford useful comparison. The scapula lacks the distal end of the blade. The greatest interest is found in the limb bones, as it is in these that the details attributed to specific difference are indicated. The wing elements have been described sufficiently above. In the leg the femur, represented by six specimens, all nearly complete, shows no differences from modern *Tympanuchus pallidicinctus* in form. The tibiotarsus has the condyles relatively smaller, but the measurements of total length, in the three specimens sufficiently complete to afford these data, fall within the limits shown by the two sexes of the living bird. The same is true in the total length of the two complete tarsometatarsi, but the fossil bones are more slender than those of the living species.

In summary, the skeletal elements indicate a bird slightly less in size than the modern Lesser Prairie Chicken, marked by heavier bill, and shorter, smaller wings, that stood about as tall as its living relative, but with more slender legs. It appears to have been of related origin with *T. pallidicinctus*, but not directly in the evolutionary line of that species.

Dr. Brown in his original account (1908, p. 159) located the Conard Fissure site as "four miles west of Willcockson." This is shown as a country settlement on the Harrison topographical sheet of 1905 of the U. S. Geological Survey, and is marked in some of the older atlases. It is not a post office, and is not found on newer maps.

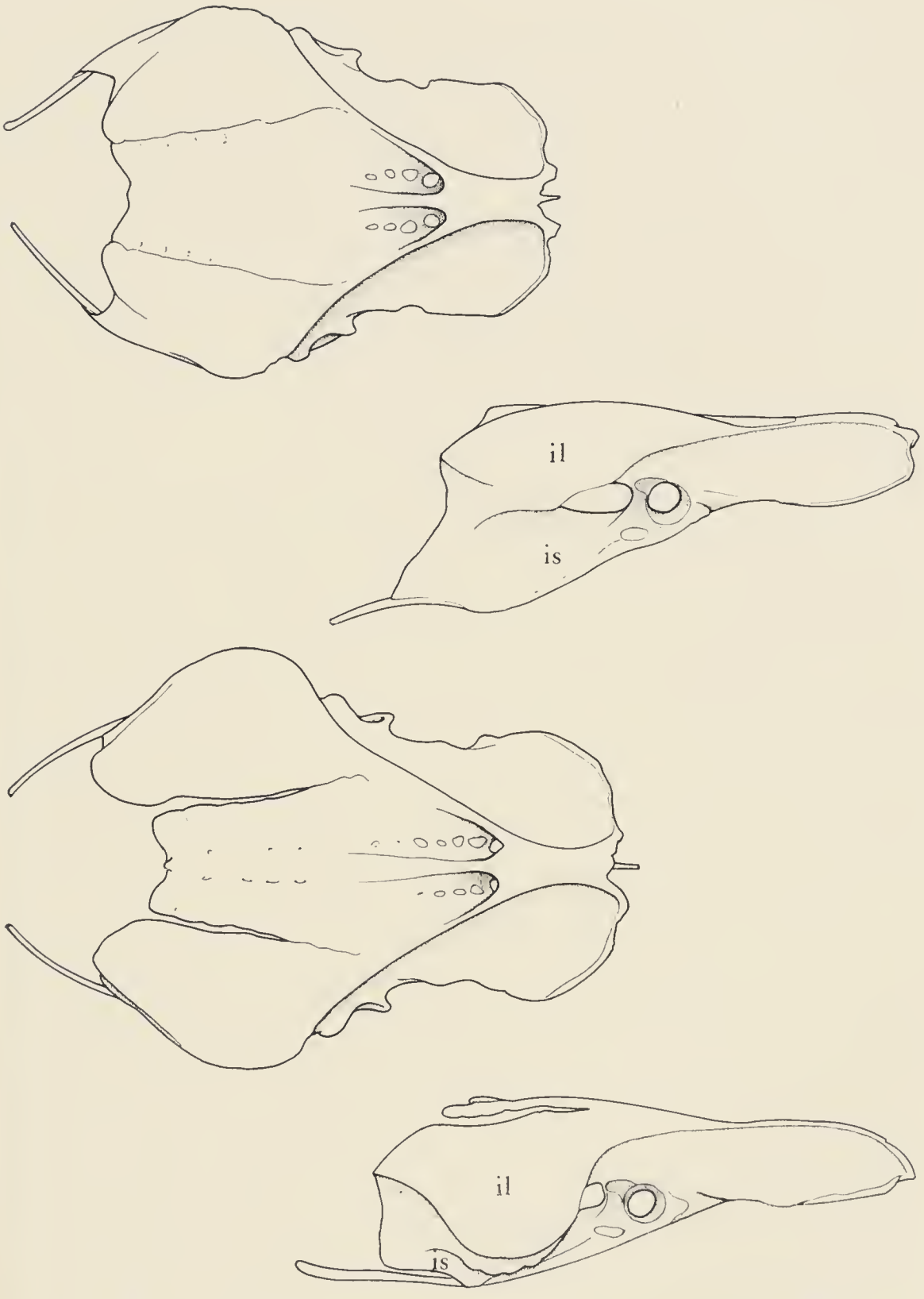
An important matter at the beginning of the examination of this Conard Fissure material was the determination of the characters found in the skeleton to separate the two currently accepted genera, *Tympanuchus* and *Pedioecetes*, since the general over-all appearance of the fossil placed it as a grouse of one of these two categories. I have had available in this study a series of 8 *Pedioecetes phasianellus columbianus* from Montana to represent that group, 4 *Tympanuchus pallidicinctus*, 2 of the recently extinct *Tympanuchus cupido cupido* from Massachusetts, and 3 *Tympanuchus c. pinnatus* from North Dakota. In life the modern species of *Tympanuchus* are marked by rounded tail, a prominent air sac bare of feathers on the sides of the neck (less evident in females), over which there is a tuft of elongated feathers in the male sex. *Pedioecetes phasianellus* has four central rectrices elongated to project prominently beyond the others, and lacks the bare area over the air sacs and the elongated neck feathers of the other group. Habitat and general habits are fairly similar in the two, and both gather in spring on display grounds where the males strut, posture and call. In detailed examination of the skeleton, element by element, beginning with the skull and continuing through sternum, pectoral girdle, wings, pelvis and posterior limb, I find that the only definite characters to separate the two groups of species appear in the pelvis. Details evident in other parts of the skeleton serve to identify species but are not valid to separate the two groups recognized as genera.

In *Pedioecetes phasianellus* the posterior section of the sacrum, viewed from above, is only slightly narrowed posteriorly, and remains in close contact with the ilium to the posterior border of the pelvis. Viewed from the side the posterior end of the ilium is produced as a point. From this same view the ischium below, and particularly behind, the ilio-ischiadic foramen is decidedly broadened. Overhang of the free border of the ilium over the foramen in question is slight. (See Figs. 1–2.)

In the forms of the genus *Tympanuchus* the posterior end of the sacrum, when viewed from above is narrowed, and does not extend to the end of the ilium (with or without an additional caudal element coalesced with it). Both internal and external angles of the posterior border of the ilium are rounded, and both, in this area, are free, the inner one from the posterior end of the sacrum, and the outer one from the projecting shaft of the pubis. Viewed from the side the ischium is narrowed, with the outer margin of the post-acetabular portion of the ilium projecting above it as a pronounced overhang. (See Figs. 3–4.) This projection is evident in both sexes but usually is broader in males.

There is enough of the sacrum preserved in the material of *ceres* to demonstrate that this species is a member of the genus *Tympanuchus*.

The specimen forwarded by Mr. John E. Guilday found in Lloyd's Rock Sinkhole, in the New Paris Sinkholes, one and one-half miles northeast of New Paris, Bedford County, Pennsylvania, collected September 21, 1958, is represented by all of the important parts of the skeleton. While these bones were in mixed association, they appear to come from one individual, since there is no duplication among them, and the paired elements represent right and



FIGS. 1–2. (*above*) Dorsal and lateral views of pelvis in the Sharp-tailed Grouse, *Pedioecetes phasianellus columbianus* (¾ natural size).

FIGS. 3–4. (*below*) Dorsal and lateral views of pelvis in the Greater Prairie Chicken, *Tympanuchus cupido pinnatus* (¾ natural size).

left sides. The pelvis (and the other bones) indicate clearly that the bird is the Sharp-tailed Grouse (*Pedioecetes phasianellus* [Linnaeus]), this being the first Pleistocene record for the species in eastern United States. Mr. Guilday interprets the considerable mammalian fauna with which the bird was found as a more boreal association than that of the present day in Bedford County. The presence of the grouse does not militate against this, as this species at present ranges north into northern Manitoba, northern Ontario, and Quebec. In modern times it has not been found in the United States east of northern Michigan. The fossil is believed to date back to late Wisconsin time.

There were a number of bones of the Ruffed Grouse (*Bonasa umbellus*) associated with the other species, affording another Pleistocene locality for this wide-ranging species.

Literature Cited

Brown, B.

1908 The Conard Fissure, a Pleistocene bone deposit in northern Arkansas: with descriptions of two new genera and twenty new species of mammals. *Mem. Amer. Mus. Nat. Hist.*, 9(pt. 4):155–208.

Shufeldt, R. W.

1913 Further studies of fossil birds with descriptions of new and extinct species. *Bull. Amer. Mus. Nat. Hist.*, 33(art. 16):285–306.

Smithsonian Institution, Washington 25, D. C., January 19, 1959

A PLEISTOCENE AVIFAUNA FROM ROCK SPRING, FLORIDA

BY GLEN E. WOOLFENDEN

Rock Spring issues from a limestone bluff approximately 6 miles north of Apopka, Orange County, Florida, in the north-central portion of section 15, T. 20 S., R. 28 E. The fossils here reported were taken from Rock Spring Run within 200 yards of the source. The bone-bearing, argillaceous sands represent an old channel fill overlying the Ocala limestone, which is exposed in portions of the stream bed. Lateral erosion of the sands exposes the fossils. The bones are well mineralized and most are not waterworn. The frequent occurrence in association of bones from what appear to be the same individual indicates that the material has not been reworked and that the bones are the same age as the matrix. Pleistocene age of the site is indicated by the presence of mastodon (*Mammut americanus*), horse (*Equus* sp.), tapir (*Tapirus veroensis*), peccary (*Platygonus* sp.), and camel (*Tanupolama mirifica*) in association with the bird material.

H. James Gut (1939) discovered the site; John Mann, Jack Todd and, particularly, Gerald Lintner obtained additional specimens. This report is based on all the avian elements the four collected. The material is now in the collection of Pierce Brodkorb at the University of Florida.

Avifauna

The total number of bird bones available was approximately 1025, of which more than half were identifiable to species (Table 1). The 35 species and one additional genus determined make this locality one of the richer avian fossil deposits known. Four species are additions to the list of fossil birds of North America; four others are reported for the first time as fossils from Florida.

Gavia immer was known previously as a fossil in North America only from the Pleistocene of California, although Brodkorb (1953:214) refers to an ulna from Lake Monroe, Volusia County, Florida, as "near *immer*." Complete bones included in the 47 specimens from Rock Spring are three coracoids, two carpometacarpi, and one each of the following: humerus, ulna, radius, femur, and tibiotarsus. The major portion of a cranium is also present.

Among the 29 bones identified as *Ardea herodias* is an extremely large carpometacarpus 116.4 mm. in length. The length of the carpometacarpus in three *A. occidentalis* ranges from 96.4 to 100.9 mm.; in 33 *A. h. herodias* from 93.5 to 107.1 mm.; and in three *A. goliath* from 97.4 to 103.6 mm. (Adams, 1956 MS:70, 74, 75). The carpometacarpus in five *A. h. wardi* ranges from 108.0 to 113.0 mm. I can detect no qualitative differences between the fossil and *A. herodias*, and it seems likely that the fossil would fit within the range of a larger series of *A. h. wardi*.

In addition to the four elements assigned to *Nycticorax nycticorax* is the distal 20 mm. of a right tarsometatarsus that differs in several characters. The trochlea for digit 2 does not protrude as far medially and posteriorly, and the trochlea for digit 4 is extended

distally, thus the three trochleae appear more equal and parallel than in other herons; also the metatarsal facet lies closer to the trochleae. Measurements of the fossil are as follows: width of shaft distal to metatarsal facet, 6.3 mm.; width through condyles, 10.3 mm.; distance from distal end to center of metatarsal facet, 11.4 mm. This element, which was compared with all North American herons and some extralimital forms, may represent an additional species.

Ajaia ajaja was known previously as a fossil only from the Pleistocene of California. The Rock Spring deposit yielded the distal portion of a right tarsometatarsus.

Of the 1025 bird bones 620 were those of ducks. I was able to assign approximately half of these to eight species. *Aix sponsa* is recorded on the basis of a complete right humerus. Shufeldt's specimens of this species from Fossil Lake, Oregon, have been assigned to *Spatula* by Howard (1946:176). More recently, Pleistocene records of the species have been published for Ontario (Wetmore, 1958:9) and Kansas (Stettenheim, 1958:198). The Rock Spring specimen constitutes the first fossil record of this species from Florida.

Mergus serrator, hitherto known as a fossil only from Oregon, is the most abundant bird in the Rock Spring deposit. Maxillae, mandibles, portions of the syrinx, as well as whole specimens of all the long bones are present.

Aythya collaris was recorded from the Pleistocene of Crystal Springs, Florida, by Brodkorb (1956:158), but was published too late to be incorporated in the fossil checklist (Wetmore, 1956).

A method of separating the humeri of the Anatinae from those of the Aythyinae, based on certain characters of the pneumatic fossa, became apparent while working on the duck material from Rock Spring. In the Anatinae the fossa is deeper and partially excavates the medial bar. The construction is such that the palmar surface of the bar is not completely visible. Furthermore, the fossa usually possesses many bony struts. In the Aythyinae the pneumatic fossa is shallower, and the medial bar is essentially continuous with the shaft, exposing its palmar surface. Struts within the fossa are rare; in most cases the wall is solid. These characters enabled me to assign more than 100 specimens of river and diving ducks to their respective subfamilies; the specimens included several extralimital forms and all North American species with the exception of *Anas diazi*, *Bucephala islandica*, and *Camptorhynchus labradorium*. The humeri of two specimens of the Rosy-billed Pochard (*Metopiana peposaca*) of South America agree in all respects with those of the Anatinae. This deviation from what seems a reliable method of distinguishing the two subfamilies may be of phylogenetic significance, for Delacour and Mayr (1945:25–26) consider *Metopiana*, along with *Netta rufina* and *Aythya erythrophthalma*, to "constitute a bridge between the river ducks and the more specialized pochards of the genus *Aythya*. . . ."

Four bones in the collection belong to the order Charadriiformes. I was able to identify one of these to species and two to genus. A left tibiotarsus, lacking only the cnemial and rotular crests, is of *Limnodromus scolopaceus*. The element measures 60.0 mm. from distal condyles to proximal articulating surfaces. The same measurement taken from eight specimens of *L. scolopaceus* ranged from 55.4 to 65.4 mm.; seven specimens of

L. griseus vary from 52.2 to 55.7 mm. Although *L. griseus* has been reported from the Pleistocene of California, this is the first record of *L. scolopaceus* as a fossil.

The distal three-quarters of a left humerus and a fragment of the distal portion of a

TABLE 1

PLEISTOCENE BIRDS FROM ROCK SPRING, FLORIDA

Species	No. of bones	No. of individuals
Gavia immer. Common Loon	46	3
Podiceps auritus. Horned Grebe	1	1
Podilymbus podiceps. Pied-billed Grebe	18	4
Phalacrocorax auritus. Double-crested Cormorant	106	8
Anhinga anhinga. Anhinga	14	2
Ardea herodias. Great Blue Heron	29	3
Casmerodius albus. Common Egret	7	1
Nycticorax nycticorax. Black-crowned Night Heron	4	1
Botaurus lentiginosus. American Bittern	2	1
Ciconia maltha. extinct stork	2	1
Ajaia ajaja. Roseate Spoonbill	1	1
Anas fulvigula. Mottled Duck	2	1
Anas acuta. Pintail	1	1
Anas carolinensis. Green-winged Teal	4	2
Anas discors. Blue-winged Teal	4	2
Aix sponsa. Wood Duck	1	1
Aythya collaris. Ring-necked Duck	3	2
Aythya affinis. Lesser Scaup	55	15
Mergus serrator. Red-breasted Merganser	226	24
Coragyps atratus. Black Vulture	1	1
Buteo jamaicensis. Red-tailed Hawk	1	1
Haliaetus leucocephalus. Bald Eagle	2	1
Pandion haliaetus. Osprey	11	1
Meleagris gallopavo. Turkey	10	2
Grus canadensis. Sandhill Crane	6	2
Aramus guarauna. Limpkin	40	6
Gallinula chloropus. Common Gallinule	1	1
Fulica minor. extinct coot	1	1
Limnodromus scolopaceus. Long-billed Dowitcher	1	1
Larus sp. undetermined gull	2	1
Ectopistes migratorius. Passenger Pigeon	1	1
Strix varia. Barred Owl	2	1
Megaceryle alcyon. Belted Kingfisher	1	1
Dendrocopos borealis. Red-cockaded Woodpecker	1	1
Corvus ossifragus. Fish Crow	1	1
Richmondena cardinalis. Cardinal	1	1
Totals	609	98

left carpometacarpus are from a large gull, genus *Larus*. The fossil humerus shows minor differences from humeri of one *L. hyperboreus* and of two *L. marinus*, particularly in the region of the internal condyle and the entepicondyle. The fossil possibly represents an undescribed species. Its measurements are: greatest width of the distal condyles, 20.5 mm.; least width of the shaft, 9.0 mm.

The proximal portion of a left humerus of *Megaceryle alcyon* is the first fossil record of any member of the order Coraciiformes from North America. The bone agrees in all respects with that of the modern species.

Dendrocopos borealis, hitherto unrecorded as a fossil, is included on the basis of a partial left humerus. The genus *Dendrocopos* has been recorded from the Pleistocene of Carpenteria, California, by Miller and DeMay (1942:121, 68).

Four bones from Rock Spring are from passerine birds. Two were identified to species. *Richmondena cardinalis*, represented by a complete right carpometacarpus, was previously unknown as a fossil. *Corvus ossifragus*, represented by a fragmentary coracoid, is recorded from several other Pleistocene deposits in Florida.

Paleoecology

Most of the species from the Rock Spring deposit normally occur in riparian or aquatic situations. Certain of these, particularly *Podilymbus podiceps*, *Anhinga anhinga*, *Anas discors*, *Aix sponsa*, *Aramus guarauna*, and *Gallinula chloropus*, are generally inhabitants of fresh water. Three species of ectothermal vertebrates, *Rana catesbeiana*, *Chelydra* cf. *serpentina*, and *Alligator mississipiensis*, further substantiate a fresh-water environment at the time of deposition.

Together with the fresh-water species are three birds generally found on salt water in Florida. These are *Mergus serrator*, by far the most abundant species in the collection, *Gavia immer*, and *Podiceps auritus*. The occurrence together of species generally associated with salt water with those associated with fresh water suggests that the sea was nearer to the spring than at present.

The spring lies immediately east of the Pamlico shore line (MacNeil, 1950, map), and it seems likely that the bones were deposited during Pamlico or post-Pamlico time. The Pamlico shore line represents a rise of the sea some 25 to 35 feet above its present level. This rise in sea level probably made Rock Spring Run a sluggish depositing stream, possibly subjected to tidal flow.

Acknowledgments

Specimens were borrowed from the Museum of Zoology, University of Michigan, through the courtesy of Robert W. Storer. Measurements of specimens of *Limnodromus* at the Museum of Vertebrate Zoology, Berkeley, were obtained through Frank A. Pitelka and William J. Hamilton III. Pierce Brodkorb assisted in determining certain elements and in preparation of the manuscript. H. K. Brooks clarified geological aspects of the area, and Walter Auffenberg aided in the identification of the reptiles and amphibian. To these men I am grateful.

Literature Cited

Adams, C. T.
1956 MS Comparative osteology and phylogeny of the family Ardeidae. (Ph.D. thesis, University of Florida.)

Brodkorb, P.
1953 A review of the Pliocene loons. *Condor*, 55:211–214.
1956 Pleistocene birds from Crystal Springs, Florida. *Wilson Bull.*, 68:158.

Delacour, J., and E. Mayr
1945 The family Anatidae. *Wilson Bull.*, 57:3–55.

Gut, H. J.
1939 Hitherto unrecorded fossil localities in south-central Florida. *Proc. Florida Acad. Sci.*, 3:50–53.

Howard, H.
1946 A review of the Pleistocene birds of Fossil Lake, Oregon. Pp. 143–195 *in* *Carnegie Inst. Washington Publ.* no. 551.

MacNeil, F. S.
1950 Pleistocene shore lines in Florida and Georgia. *Geol. Surv. Prof. paper 221-F*, pp. 95–107.

Miller, L., and I. DeMay
1942 The fossil birds of California. *Univ. Calif. Publ. Zool.*, 47(4):47–142.

Stettenheim, P.
1958 Bird fossils from the late Pleistocene of Kansas. *Wilson Bull.*, 70:197–199.

Wetmore, A.
1956 A check-list of the fossil and prehistoric birds of North America and the West Indies. *Smithsonian Misc. Coll.*, 131(5):1–105.
1958 Miscellaneous notes on fossil birds. *Smithsonian Misc. Coll.*, 135(8):1–11.

Department of Biology, University of Florida, Gainesville, Florida,
April 8, 1958

GENERAL NOTES

The behavior of two captive ostriches at a burning leaf pile.—Two ostriches in the collection of the New York Zoological Society at Bronx Park have shown great interest in piles of leaves burning in their enclosure each fall. The two birds are exhibited with cranes and antelope on a large, enclosed, rolling meadow called "The African Plains."

A typical instance, recorded by movie camera and observer during the fall of 1958, occurred on the 3.7-acre African Plains Exhibit: a keeper ignited a pile of leaves about three feet in diameter and then retired. As he left, the ostriches approached the fire, the female leading, and, after several short pauses when the birds watched the fire closely, the female lowered her head and walked into the smoke directly before the burning leaves. The male continued to stand off, perhaps 15 feet away, watching. Flames could be seen plainly among the leaves as the female preened her neck, raised folded wings (over her back), and lowered herself on her tarsi. The bird's breast extended over the edge of the burning pile and smoke engulfed the forepart of her body. Glowing ashes and small flames were still visible very close to the bird. She kept her wings raised but waved them regularly in short movements over the back. The body plumage was moderately raised. Finally the bird lowered herself to her breast, protruding well into the smoking edges of the leaf pile, and continued to wave her wings. The neck was not extended nor was the mouth obviously open. When the female arose she preened her neck briefly and walked away from the smoking heap. The male approached her and began courtship display, eventually chasing her to the far end of the enclosure.

The female performs most often at the burning leaf piles, though keepers report that the male indulges in exactly the same activity. I have not observed the male at the fire. While these performances have not been timed and the character of the fire has varied from time to time, the ostriches rarely spend more than two or three minutes at the leaf pile. Frequent keeper observations confirm that the male often displays to and chases the female when she arises from the leaf pile. Crowned Cranes and a European Crane in the same enclosure have not been observed at the leaf piles. The female ostrich (*Struthio camelus australis* Gurney) was received as an adult in 1947. The male (*S. c. massaicus* Neumann) was acquired as a half-grown bird in 1955.

The motivation and degree of relationship of this behavior to anting, bathing, sunning, dusting or even smoke bathing is difficult to delineate. Smoke bathing as described by Ridley (1948. *Brit. Birds*, 41:83) for Jackdaws, White (1948. *Brit. Birds*, 41:244) for Herring Gulls, and Stevens (1948. *Brit. Birds*, 41:244) for the Black-headed Gull, for example, does not appear to be entirely of the same nature though it certainly may be related. Of course, the ostrich is a specialized form and differences in behavior may be expected. Ambient temperatures (fall) were usually low when the birds performed at the fire, but the female has performed on quite warm days. The birds' attitude and movement at the fire is somewhat reminiscent of dust bathing with wing movements, perhaps, inhibited by the fire. It might be that anticipatory dust bathing is implied in the short wing movements. In this connection, however, the birds have not been seen dusting in unburned leaf piles, or ashes from burned piles, and not even in warm ash piles. Actual visible flame has been present, in most cases, when the birds have become interested in the heaps. Furthermore, the action of the female seems the result of strong motivation, for she may be counted upon to perform with fair regularity despite the presence of observers in places where the birds are not used to seeing visitors. We seldom see normal dusting in these two captive birds. Such dust bathing as I have noted in other specimens and would expect to be normal, resembled the dusting behavior of gallinaceous birds such as quail. Ostriches and rheas may get down in scrapes in sand or earth, work themselves

over on one side, rub their necks upon the ground and throw, with their wings, considerable material over their backs and through the plumage. This sort of dusting is an activity easily inhibited by the presence of observers.

We cannot eliminate the learning factor in captive birds, or, for that matter, in wild birds, and the possibility remains that the lack of some natural element in the birds' wild environs may have provided a drive leading to artificial behavior. However, this possibility does not provide an explanation for the observed behavior.

The movement, posture and general attitude of the ostrich's activity do not suggest rigid stereotypy or the "ecstasy" reported in some birds during anting and sunning. Whitaker (1957. *Wilson Bull.*, 69:195–262) lists heat or the "thermogenic" element as "a probable factor in most anting situations," and Lanyon's (1958. *Wilson Bull.*, 70:280) observations on meadowlarks seem to establish heat rather than light as the major factor in the sunning behavior of this species. We believe heat to be a major factor in the ostriches' behavior, though their actions at the leaf pile did not resemble either of the two postures we have usually associated with ostrich sunning, and we know of no "anting" reports for ostriches. Ostriches, when sunning, may be seen standing with mouth partly open, plumage raised and wings slightly extended, or, occasionally, we see a bird resting upon its breast with wings partially extended on the ground and the head and neck folded over the back.

The leaf pile activities of the ostriches do not conform with examples in Whitaker's (*Ibid.*) anting compilation or with such anting behavior we have noted, either in an "active" or a "passive" sense.

Of course, the limits of behavior termed anting, bathing, dusting, or sunning are arbitrary at best. Chisholm (quoted by Whitaker) summed it up nicely: "Smoke-bathing may in fact be complementary to water-bathing, sun-bathing and dust-bathing, and all four may well be allied to 'anting' with acids." The Zoo Curator, working day-in and day-out with live birds, has great opportunity to watch bathing, sunning and even anting activities in many diverse species, and soon may tend to think of these behavior patterns as points on a continuum. For example, we may suggest a very close connection between anting and sunning and, perhaps, we may think of these activities as the same basic response varied by position and focus of stimulus. Thus "active" anting may be a response to an extremely localized "thermogenic" stimulus, while sunning, involving, as Lanyon (*Ibid.*) says: "sudden warming of the bird's immediate environment," may be a more general reaction to a more diffuse heat source. Thus, a bird ants with a hot match stick but suns to hot air. Between these two peaks of behavior, but within the same range, may we not also situate passive anting involving postures and reactions intermediate between sunning and anting with modifications perhaps dependent upon the moderately localized stimuli of numbers of ants rather than the focused stimulus of a single ant or wad of ants. Furthermore, those who have watched a diverse collection of captive birds will be familiar with the similarity of bathing and dust-bathing in a number of transitional forms. Many will have observed certain birds of prey and pigeons assuming the same postures during rainfall as during sunning and noted that dusting is most frequently associated with a heat factor. At the Zoo we find our quail and pheasants dusting in the sunny parts of their cages, in places changing with the movement of the sun where there is heat. We have observed birds dusting on ant hills and in warm oily soil, all of which provide connecting links in the chain of relationships of these behavior patterns. This general synthesis presents a problem for study long overdue.—William G. Conway, *New York Zoological Society, New York 60, New York, January 21, 1959.*

Strife over a nesting site between Downy and Red-headed Woodpeckers.—On April 24, 1956, a pair of Downy Woodpeckers (*Dendrocopos pubescens*) began construction of a nest approximately 20 feet from ground level in a dead lombardy poplar in a woodlot in St. Paul, Minnesota. The woodlot, some 4.5 acres in extent, is composed primarily of boxelder (*Acer Negundo*) and lombardy poplar (*Populus niger* var. *italica*) with an understory of gooseberry (*Ribes* sp.), honeysuckle (*Lonicera* sp.) and common lilac (*Syringa vulgaris*). The nest was successfully established and was occupied until May 18.

On that date, at 2:30 p.m., a Red-headed Woodpecker (*Melanerpes erythrocephalus*) was first observed in the woodlot. This woodpecker flew to a poplar tree about 10 feet from the Downy Woodpeckers' nest. It was immediately harassed by both Downys which flew close by in sweeping dives, emitting loud, scolding cries as they approached within four or five feet of the Red-headed Woodpecker. After several minutes of this fluttering, during which time the latter remained stationary, the Downys flew to nearby trees. One perched on either side of the *Melanerpes*, but not between it and the nest. The Downys shook their heads vigorously in an up-and-down motion in the direction of the intruder and continued their loud cries. The Red-headed Woodpecker seemed to ignore their defensive behavior and flew to the nest entrance. It began to enlarge the entrance hole immediately, and, after several minutes, could place its head and shoulders within. At this point the owners' display increased in intensity. They flew at the intruder with their fluttering dives, approaching more closely until they were diving to within six inches of their adversary. After several of these close dives, the Red-headed Woodpecker would leave the nest entrance momentarily and fly directly at the Downys. The latter would fly away at its approach, and were chased until they were 20 to 30 feet from the nest tree. The intruder would then return to the nest entrance and continue the enlarging process. The Downys came back to within 10 feet of the nest tree, and resumed their fluttering dives, gradually working closer until they were again diving to within six inches of their adversary. At this point the intruder drove them away from the nest tree again and the entire process was repeated. This procedure took place four or five times from 2:30 p.m. to 3:50 p.m., at which time the Red-headed Woodpecker discontinued enlarging the entrance to the nest and flew out of sight toward the east.

Immediately upon departure of the Red-head, the male Downy returned to the nest. He appeared very cautious, and several times partially entered the nest before finally going inside. He then cleaned the nest of the debris caused by the enlarging processes. During this time his mate sat in a tree about three feet from the nest.

After a period of about 10 minutes, the Red-headed Woodpecker returned to the nest. As he approached, the male Downy left the nest, possibly warned by his mate which emitted the chirping cry when their adversary came into view, and the entire process as outlined above was repeated. After approximately one-half hour of work on the nest entrance, during which the Downys were driven away several times, the Red-head again voluntarily left the nest, and flew directly to an oak tree approximately 400 feet east of the Downy Woodpeckers' nest. It was met at the oak tree by its mate, which had not been noticed previously. Both then flew to the Downy Woodpeckers' nest.

During the Red-head's absence, the male Downy Woodpecker had again cleaned the debris from the nest. However, at 4:45 p.m., when both male and female Red-headed Woodpeckers returned to the nest, the Downys left the area without an attempt to drive the intruders from the nest, and were not seen near the nest thereafter.

It is not known if the Downys had a clutch of eggs in the nest, but their long period of tenancy indicates that they probably were in the process of incubation. The Red-

headed Woodpeckers were still in possession of the nest during the first week in June when observations in the woodlot were terminated.

A Downy Woodpecker nest, newly constructed, was found on May 24, approximately 450 feet from the other Downy nest. Since Downy Woodpeckers were not noticed using the woodlot previously, it is believed that this was a re-nesting attempt by the pair ousted by the Red-headed Woodpeckers.—R. G. Schwab and J. B. Monnie, *Department of Entomology and Economic Zoology, University of Minnesota, St. Paul 1, Minnesota, June 24, 1958.*

Pilot black snake and nesting Pileated Woodpeckers.—In May, 1957, I observed a pilot black snake (*Elaphe obsoleta*) which remained close to the nest of a pair of Pileated Woodpeckers (*Dryocopus pileatus*) over a period of five days. The nest was 40 feet from the ground in a dead stump in a swamp, near Seneca, Maryland, and contained small young, as judged by the behavior of the parents and the *churr* notes which attended their visits.

Pilot black snakes are effective predators of nestling birds. This fact may be illustrated by the following examples: 1) On June 15, 1952, I killed one of these snakes as it was leaving the nest of a Catbird (*Dumetella carolinensis*). The snake's stomach contained four well-feathered young catbirds. 2) Hoyt (1957. *Ecology*, 38: 246–256) cites the experience of Rhein, who took films of a pilot black snake as it climbed a tree trunk and entered the nest of a Pileated Woodpecker, from which it was later removed in the act of swallowing the well-developed young. Having seen Rhein's film, I was startled on May 18 to discover that a 5-foot black snake was at a level with the nest of the Pileated Woodpeckers. The snake disappeared into a crevice behind and above the nest entrance. When its head reappeared in a small hole 10 minutes later, the male woodpecker also had its head out, directly below that of the snake. The two heads were about three feet apart. I now heard *cuk, cuk*'s as the female Pileated Woodpecker alighted on a nearby tree, flew to the entrance, and then entered after her mate flew out. The snake withdrew from sight during this change-over. Two inches of its head and neck emerged from the same hole 15 minutes later, but the female woodpecker remained out of sight.

I watched the nest hole for 30 minutes on May 19. The snake put its head out the small hole for a few minutes during this time. My next visit was on May 23. The sun was coming out after three days of cold, wet weather, and the pilot black snake was partly stretched on a broken limb where I had first seen it on May 18. On May 23 the male woodpecker had his head and neck well out as if trying to see the snake a foot away and around the curvature of the stump. Neither animal appeared to be excited. The snake moved with great slowness, taking 28 minutes to descend to the ground where it disappeared in the vegetation before I could catch it. Subsequent observations indicated that the Pileated Woodpeckers were successful in raising their young.

It was not apparent that the snake could have entered the nest hole of the Pileated Woodpecker. One or the other of the parent birds was always inside. This continuous attendance on small young is, in my experience, common to other species of woodpeckers. The situation is different when the young are more developed. Parent birds then spend more time collecting food and, in the case of Pileated Woodpeckers, the nest may be visited only at intervals of 30 to 60 minutes. The pilot black snake might be more dangerous at this later period which was, I believe, the one photographed by Rhein. One can only conjecture why the snake was in the stump. It may have been laying eggs, or simply resting over a period of cold weather without primary interest in the young Pileated Woodpeckers stirring within their nest a few feet away.—Lawrence Kilham, *7815 Aberdeen Road, Bethesda, Maryland, January 14, 1959.*

The plight of the bluebird in Michigan.—The plight of the Eastern Bluebird (*Sialia sialis*) over much of its range in eastern United States is rapidly becoming a matter of record (see *Audubon Field Notes*, Vol. 12, Nos. 3 to 6, 1958). To this I wish to append my meager Michigan data for the spring, summer, and fall of 1958.

In April and May several people called me to ask what had happened to the bluebirds. People who had had bluebird tenants for many years had none this spring. A check of my own records showed that up to May 24 I had no Ingham County observations of this species; my only notebook entry was of a bird heard "warbling," but not seen, on April 19, about 10 miles north of St. Johns in Clinton County.

On May 24 six students and I took our annual May-day count in which we cover, in marathon fashion, all of the better known local birding spots. Increasingly conscious of the difficulty we might have in adding the bluebird to our list we covered many miles of promising habitat before getting our first and only record along a back road west of Lansing. Another segment of our searching party also located one bluebird. This west Lansing bird proved to be my only Ingham County record for 1958, but Mrs. Walter Halliday, who had been checking all spring on the disappearance of bluebirds from their former Okemos nesting sites, reported that she had finally located an occupied nesting box and that it produced young. Other local observers reported similar experiences, i.e., few or no bluebirds. Only four spring records were turned in for the Michigan Audubon Society's Bird Survey report.

During the summer session at our Gull Lake Biological Station I had difficulty finding bluebirds anywhere in the several counties covered on field trips. On June 28 I spotted one on a telephone wire on M-89 near Augusta (Kalamazoo County), but was not able to relocate it on several subsequent visits to that area. On July 25, however, we found a pair along a back road in Allegan County, near Fennville.

In September Mrs. Wallace and I took a 12-day trip into the eastern part of the Upper Peninsula. Though well aware by then of the state-wide scarcity of bluebirds, I had some expectations of finding them assembling on roadside wires, as is their custom at that time of year. Our first two bluebirds were encountered on September 8 near Wolverine, 204 miles (by my odometer) north of East Lansing. Our next record was 10 days and approximately 1,000 miles later, when we located a group of six birds along a gravel road near Moran in Mackinac County. In six days of observations on fall migration at Whitefish Point, Chippewa County, where we recorded 77 species of birds between September 11 and 17, we did not see or hear a single bluebird. We also made a cursory check of the Gould City area (Mackinac County), where Dr. Karl Christofferson told us he had formerly seen large flocks (up to 75 in one count) in September and October. We found none in about 10 miles of slow driving (with frequent stops to look and listen) along back roads. At his station in Blaney Park, Dr. Christofferson had one pair of nesting bluebirds this summer in the 60 boxes he has provided for birds.

Our only other bluebird record on this 1,668-mile trip, mostly in ostensibly favorable bluebird country, was of two birds perched on wires along U.S. 27 near Otsego Lake on September 19—a total of 10 birds in three places in 12 days of observations. By contrast we counted 31 Sparrow Hawks (*Falco sparverius*) in about 15 different places (average of two per locality), mostly along roadside wires, as the bluebirds should have been.

Some of the reasons for the decline of the Eastern Bluebird over much of its former range are not hard to assess. It suffers from competition with more aggressive hole-nesting species, such as the Starling (*Sturnus vulgaris*) and the House Sparrow (*Passer domesticus*). Even native birds, such as Tree Swallows (*Iridoprocne bicolor*) and House Wrens (*Troglodytes aedon*), often win out in conflicts with bluebirds (Batts, 1958. *Jack-pine Warbler*, 36:138). Bluebirds are also subject to severe climatic changes—the un-

precedented winter of 1958 will go down in history as a disaster of major proportions for bluebirds and other insectivorous species that winter in the southern states. Many people suspect insecticides, but the evidence for this rests largely in the disappearance of the species from modern orchards, croplands, and roadsides in settled areas. Some bluebirds are showing up among the many victims of the ill-conceived fire-ant control program in the southeast; completion of the projected program, which comprises a large part of the Eastern Bluebird's winter range, might well write the finish of this once familiar and much beloved bird. Perhaps the key to the whole problem lies in the widespread loss of favorable habitat, from all causes. In Michigan, at least, the bluebird now seems to be largely restricted to the jack-pine areas of northern counties and the more remote, abandoned or uncultivated farmlands.—George J. Wallace, *Department of Zoology, Michigan State University, East Lansing, Michigan, January 17, 1959.*

The poisoning of meadowlarks with insecticides.—On March 6, 1958, Everett Woods, graduate student in the Department of Entomology, informed Dr. F. M. Baumgartner and me that meadowlarks were digging and eating freshly planted oat and barley seeds on a test plot at the Small Grains Laboratory. We thought it a good opportunity to test some candidate chemical bird repellents, so I went immediately to observe the plots. Twenty meadowlarks were feeding on the plots at that time. Closer observation on that date and on subsequent days revealed that the birds started by picking up scattered grain on top of the ground, digging up large pockets of grain where the planter had stopped at the end of the rows, and then starting down the rows digging up the seeds as they went. We made plans to spray the area with repellents, but adverse weather conditions all during March prevented us from doing it.

The following day, seven dead Eastern and Western Meadowlarks (*Sturnella magna* and *S. neglecta*) and a very sick one were found near the plots. A quick check revealed that the seed of each of two plots, four rows 10 feet long, had been treated with ¼ lb. to ½ lb. of Di-Syston and ¼ lb. to ½ lb. of Thimet per 100 lb. of seed, respectively. These two insecticides have an accumulative effect and are highly toxic to vertebrates. The sick bird appeared to recover fully and gain weight while being kept caged in my office. Its reactions seemed to have become normal as it soon became a pet and learned many tricks very quickly. About two months later, it suddenly quit eating and drinking and within a few days died.

Observations were continued on the plots until March 30, 1958. The meadowlarks continued to dig seed in some of the plots, and although large feeding areas and roosts were thoroughly searched, no other dead birds were found. These observations further point out the serious effects that some insecticides have on birds (Dewitt, 1957. *So. Car. Wildlife*, Fall). Indications are that unless extreme care is used when applying these chemicals very high bird mortality can be expected.—Daude N. Griffin, *Department of Zoology, Oklahoma State University, Stillwater, Oklahoma, January 7, 1959.*

Blue Jay feeding on termites.—One day during the last week of June, 1957, a Blue Jay (*Cyanocitta cristata*) flew down directly from its perch in a tree near by to feed on a mass of winged termites concentrated on the top of an old stump in the front lawn of our house at Greenbelt, Prince George's County, Maryland. It pecked avidly at these insects for about two minutes, leaving the site only when someone went to the stump to apply insecticide. The insects were identified as *Reticulitermes virginicus* by Dr. Thomas E. Snyder of the U. S. National Museum, Washington, D. C.

The relatively few sight observations of birds eating termites, summarized by Blake (1941. *Auk*, 58:104) and Cowan (1942. *Auk*, 59:451), do not include the Blue Jay.—Donald H. Lamore, *Department of Biology, Cottey College, Nevada, Missouri, August 13, 1958.*

A late record for Northern Phalarope in West Virginia.—On November 23, 1958, Gordon Knight, John L. Smith and I were searching for waterfowl on Lake Lynn of the Cheat River, Monongalia County, West Virginia, when our attention was drawn to a small bird swimming about 50 feet offshore. The bird was studied carefully for about 15 minutes with both 7× binoculars and a 30× telescope, and proved to be a Northern Phalarope (*Lobipes lobatus*). Mr. Knight and Mr. Smith were not previously acquainted with this species in life and were unfamiliar with the characters separating the three phalarope species. Accordingly, I questioned them carefully as to what they were seeing. It was agreed that the bird had the striped upper back and the thin, black bill of this species. The bird appeared to be in good condition and was feeding in the typical phalarope manner. It is of interest to note that there had been no pronounced atmospheric disturbance to bring this unusual bird to our region. It was not possible to collect the bird at the time, and when I returned on November 26 to attempt to collect it, I was unable to locate it.

There are very few previous records for this species from West Virginia. The U.S. Fish and Wildlife Service has a record from Parkersburg, Wood County, on September 26, 1888 (C. S. Robbins *in litt.*). G. Eifrig collected one on the Potomac River in Mineral County on May 23, 1901 (1902. *Auk*, 29:76). Bibbee (1934. *W. Va. Agric. Exp. Sta. Bull.* no. 258) lists two collected at Parkersburg in "the late fall" of 1922. I have found no further records and thus it appears that this is the first record for the state in the past 36 years, and is the first record for this part of the state.

Mr. Chandler Robbins has kindly furnished me with information pertaining to late dates for this species from the Fish and Wildlife Service files. The only other inland record approaching this one in lateness is apparently one from Milwaukee, Wisconsin, on November 5, 1949. Along the Atlantic Coast there are about seven records for November, three for December, and two for February. I am unable to locate any Ohio, Pennsylvania, or Maryland dates that approach this one in lateness.—George A. Hall, *West Virginia University, Morgantown, West Virginia, March 2, 1959.*

Observations at a Goshawk Nest in Northwestern Montana.—My banding station, at Sun Camp Ranger Cabin, was on the shores of St. Mary Lake, which is part of the Hudson Bay drainage system on the east side of the Continental Divide. The lake is surrounded by peaks of the Lewis Range of the Rocky Mountains in Glacier National Park, Glacier County, Montana. The latitude of 4839 is used on banding records for this Sun Point Area. The old log ranger cabin is in the forest of the Spruce–fir Zone, the Engelmann spruce–subalpine fir association of Daubenmire (1943:334–337), at 4500 feet elevation, and can be reached only by trail or boat.

In mid-July, 1956, I saw a Goshawk (*Accipiter gentilis*) darting through the tree-tops near our cabin. At intervals the call-note of *kak kak kak* was repeated. I soon discovered the cause of these staccato cries. The hawk's nest was well hidden about 60 feet up in a fork of an Engelmann spruce located only 50 feet back of our cabin along the bank of Baring Creek. The stream emerges from a canyon, drops down as Baring Falls nearby, and flows into St. Mary Lake.

Bailey (1918:147) reports sighting one Goshawk in the Many Glacier Area, and one was seen by H. C. Bryant in upper St. Mary Valley. Both areas are on the east slope of the Continental Divide and have the same type of forest habitat as St. Mary Lake. Dumas (1950:234) found the Western Goshawk in the Mixed Forest of the Montane Forest Area in S.E. Washington. Snyder (1950:23), in a study in the Rocky Mountains east of the Continental Divide in Boulder County, Colorado, found the Goshawk to be a permanent resi-

dent in the Rocky Mountain Coniferous Forest. Although Glacier is farther north than these studies, the type of forest habitat is similar. Here a tree-shaded habitat near water was selected by the nesting Goshawks. The Goshawk is found in boreal forests, generally on slopes of canyons not far from water, according to Bent (1937:139–140).

I am indebted to my son, Monty, who climbed the difficult tree regularly to make close-up observations and pictures of the birds. The nest measured 3 feet long, 2½ feet wide, and 2 feet deep. It was composed of sticks and green alpine fir branchlets which were rather loosely put together. It was lined with fir foliage and some feathers. It appeared almost flat, with only a shallow depression on the top.

The first close-up observation on July 24 revealed four young Goshawks in downy coats of silky white. The number of eggs and young was three in California Goshawk studies by Dixon (1938:5) and Ingles (1945:215). Bent (1937:128) found that the Goshawk ordinarily lays three or four eggs.

On August 5 Monty climbed the tree to band the young, but as he reached the nest all four young hopped out and fluttered down to smaller trees, hanging upside down from small branches clutched firmly in their talons. However, one young bird was strong enough to fly to the top of a nearby black cottonwood. We successfully retrieved three of the young birds but could not reach the one in the tree-top.

We photographed and banded the three young birds. Although the birds snapped their beaks they did not bite. One of the young was a runt, noticeably smaller than the others. They tried to stay out of the hot sun by moving into shaded areas. Monty then took the birds in a sack and safely returned them to the nest. As he started down he had to ward off an adult Goshawk by hitting it with his tin hat. Other observers have suffered gashes and torn clothing (Rowley, 1939:247; Dixon, 1938:4), or have been struck while walking along a trail near a nesting site (Jewett, 1953:162). The young Goshawk in the tree-top returned to perch above and near the nest but did not return to the nest, although the adults fed it near the nest.

My first week of observation was that of July 22 when the young downy Goshawks were rather quiet and inactive in the nest. During the second week, that of July 29, we had observed some fighting over food and heard much peeping sounding like baby chicks. The birds at this time arranged themselves around the outside portions of the nest.

We had banded the young birds at the beginning of the third week, August 5, and from nest observations and the juvenal plumage estimated the age of the birds to be two weeks plus. During this third week the young birds exercised daily by stretching and flapping their wings. Dixon (1948:7) found that much time was spent by the young in preening and exercising by flopping back and forth on the nest. We saw the birds take many short floppy flights from limb to limb. They tore off meat with their beaks while holding the prey with their talons. Then they sat on the edge of the nest to complete the swallowing of large chunks of meat. They regurgitated the hair and feathers of animals in pellets very similar to those of owls.

The next day after banding the young birds, August 6, an adult Goshawk "shadowed" me as I walked along the trail from the cabin through the forest. Flying from tree-top to tree-top the Goshawk uttered screams of a plaintive nature sounding like *kew kew kew*. This was probably a reaction to the disturbance of our banding activities.

The fourth week, beginning August 12, found three of the young in full juvenal plumage, but the runt remained concealed in the nest. Three of the birds were very active now and took small flights out among tree branches. Their wings were noticeably larger and they practiced maneuvering the long tail. The adults were now kept busy feeding individual young birds. They always greeted the adult with chirps which were totally out of keeping with their large size and ferocious appearance. Two birds sometimes playfully touched beaks. They no longer fought over food but ate one at a time, pulling meat apart and swallowing at the same time. The down on their legs gave the appearance of pantaloons and they acted like clumsy adolescents.

We identified, from remains of their food, a chipmunk and a golden-mantled ground squirrel. Most of their food was small mammals of this type, although a few remains of birds were found. Both Dixon (1938:9) and Ingles (1945:215) found that the food brought to the nestlings of the Goshawk was almost entirely mammals. That part of the food was wasted was indicated by the remains we picked up under the nest-tree. Sprunt (1955:45) found from stomach studies that the Goshawk eats primarily birds, but about 30% was various rodents. In our observations it seemed to be the relative abundance that caused the larger proportion of the prey to be rodents. In Glacier other birds complete their nesting early in the season, largely before the hatching of the Goshawks.

Although a bulky structure over two feet in diameter the nest had been slowly falling apart under the vigorous activities of the Goshawks. We had noted some disintegration of the nest on August 5. By August 14 only about 1/3 of the nest remained and only the runt remained in the nest. However, the young birds remained close to the nest-tree. One young bird was perched in a large cottonwood across the creek. All were calling with a loud, clear "peeping" call as they did when food was brought, in contrast to the urgent piercing call when hungry. Later the young Goshawk perched in the tree clutching a chipmunk in its talons.

On the morning of August 15 the nest had fallen apart completely and we found sections of it on the ground. The young birds were perched on and near the nest-tree.

After this the adult Goshawks fed the young by coming in rapidly to the nest-tree and dropping the dead prey, usually chipmunks. This occurred at low heights in the tree and the juveniles had to catch the falling prey, and often fought over it. This may be a method of teaching the young how to catch prey. If the prey was not caught by the juvenile hawks

it was never retrieved by the adults. The runt remained at the nest-site calling endlessly for food. The runt could not compete for food with the others with this type of feeding since it was small and had a defective leg.

On August 19 the runt of the nest flew down on the roof of the cabin several times and then would return to the nest-tree. About noon it was hanging upside down from a branch and then fell to the ground with its eyes closed. In a few minutes it was dead, probably from starvation.

For the next week we heard the birds calling nearby in the forest but they no longer returned to the nest-tree. The young birds had full juvenal plumage and resembled the adults except for down on the belly. Then we did not hear the birds after August 24 when the three juveniles were seen together calling excitedly as they did when one bird had food.

Literature Cited

Bailey, F. M.
1918 The birds and wild animals of Glacier National Park. U.S. Govt. Printing Office, Washington.

Bent, A. C.
1937 Life histories of North American birds of prey. U.S. Nat. Mus. Bull. no. 167.

Daubenmire, R. F.
1943 Vegetational zonation in the Rocky Mountains. *Bot. Rev.*, 9:325–393.

Dixon, J. B., and R. E. Dixon
1938 Nesting of the Western Goshawk in California. *Condor*, 40:3–11.

Dumas, P. C.
1950 Habitat distribution of breeding birds in southeastern Washington. *Condor*, 47:215.

Ingles, L. G.
1945 Nesting of the Goshawk in Sequoia National Park, California. *Condor*, 47:215.

Jewett, S. G., W. P. Taylor, W. T. Shaw, and J. W. Aldrich
1953 Birds of Washington State. Univ. of Washington Press, Seattle.

Rowley, J. R.
1939 Breeding birds of Mono County, Nevada. *Condor*, 41:247–254.

Snyder, D. P.
1950 Bird communities in the coniferous forest biome. *Condor*, 52:17–27.

Sprunt, A. Jr.
1955 North American birds of prey. Harper Bros., New York.

Lloyd Parratt, *500 West 14th Street, Upland, California, April 20, 1958.*

ORNITHOLOGICAL NEWS

We are happy to announce that Roger Tory Peterson has become a Patron of The Wilson Ornithological Society.

It is a pleasure to announce that Olin Sewall Pettingill, Jr., will act as review editor for the Ornithological Literature section of *The Wilson Bulletin*. All items intended for review should be sent to Dr. Pettingill at Wayne, Maine.

The Forty-first Annual Meeting of the Wilson Ornithological Society will be held in Gatlinburg, Tennessee, May 5–8, 1960. The Huff House of the Mountain View Hotel will be the headquarters.

On April 11, Mr. W. E. Clyde Todd marked his **sixtieth** anniversary at Carnegie Museum. He attained the status of Curator Emeritus in 1945, and in 1957 was appointed Honorary Curator of Oölogy in connection with the acquisition by Carnegie Museum of the egg collection of the late Herbert Brandt.

Mr. Todd became a member of the Wilson Ornithological Society in 1911 (only five current members joined the Society earlier than this).

Professor V. C. Wynne-Edwards, on leave from Aberdeen, Scotland, is currently occupying the Tom Wallace Chair of Conservation in the biology department at the University of Louisville.

About 20,000 specimens of bird and mammal stomach contents remaining in the Fish and Wildlife Service's Patuxent Research Refuge Food Habits Collection (after the recent distribution of specimens of immediate research interest to over 100 qualified research workers) have been transferred to the Department of Zoology, University of Massachusetts, Amherst, Massachusetts.

The specimens remaining will be available after February, 1960, to qualified research personnel for specific food habits studies. Address inquiries to Dr. L. M. Bartlett, Associate Professor of Zoology, Department of Zoology, University of Massachusetts, Amherst, Massachusetts.

Request for Information

In some species of animals having two or more distinct color phases, non-random mating occurs. I should like to investigate the possibility that this sort of preferential mating occurs in certain species of North American birds with two color phases. The question can be answered best by an analysis of records of a large sample of breeding pairs. Therefore I am soliciting any records of the color phases of breeding pairs of the following species: Screech Owl (*Otus asio*), red and gray forms; Ferruginous Hawk (*Buteo regalis*), dark and light forms; western Red-tailed Hawk (*Buteo jamaicensis calurus*), dark and light forms. Instances of birds of intermediate coloration would also be valuable. For the purpose of this inquiry, I need records of definitely mated pairs, no matter whether the members of the pair are the same or different in coloration. I can supply fuller details to anyone interested in participating in this work.—*D. F. Owen, Department of Zoology, University of Michigan, Ann Arbor, Michigan.*

Note

From Daniel McKinley:

For an improved version of my "Early record for the Ivory-billed Woodpecker in Kentucky" (1958. *Wilson Bull.*, 70:380–381), see "An early record and description of the Ivory-billed Woodpecker in Kentucky" by Dr. A. W. Schorger (1949. *Ibid.*, 61:235). I offer professional apologies to Dr. Schorger; to Drs. Dixon and Tanner, I can only say that no harm was meant.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

Allen Press—110 reprints
Anonymous—1 book
Virginia Armstrong—1 book
William H. Burt—1 pamphlet
E. W. Dawson—9 reprints
George E. Grube—2 reprints
Paul Hahn—1 book
Fr. Haverschmidt—3 reprints
George E. Hudson—1 reprint
Amelia R. Laskey—2 reprints
Louise de Kiriline Lawrence—1 reprint
Daniel McKinley—11 journals, 18 reprints
Jennifer Owen—1 reprint
William H. Phelps—1 reprint
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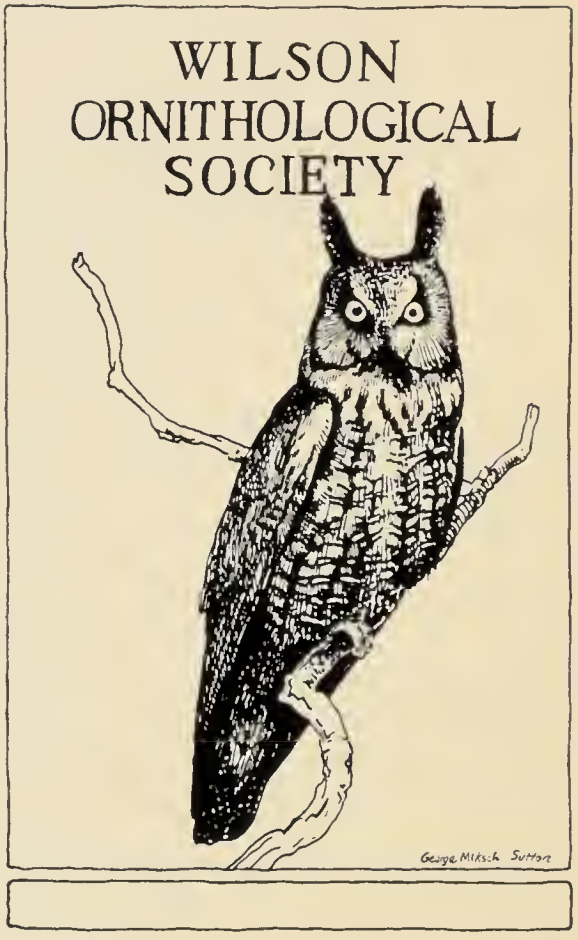

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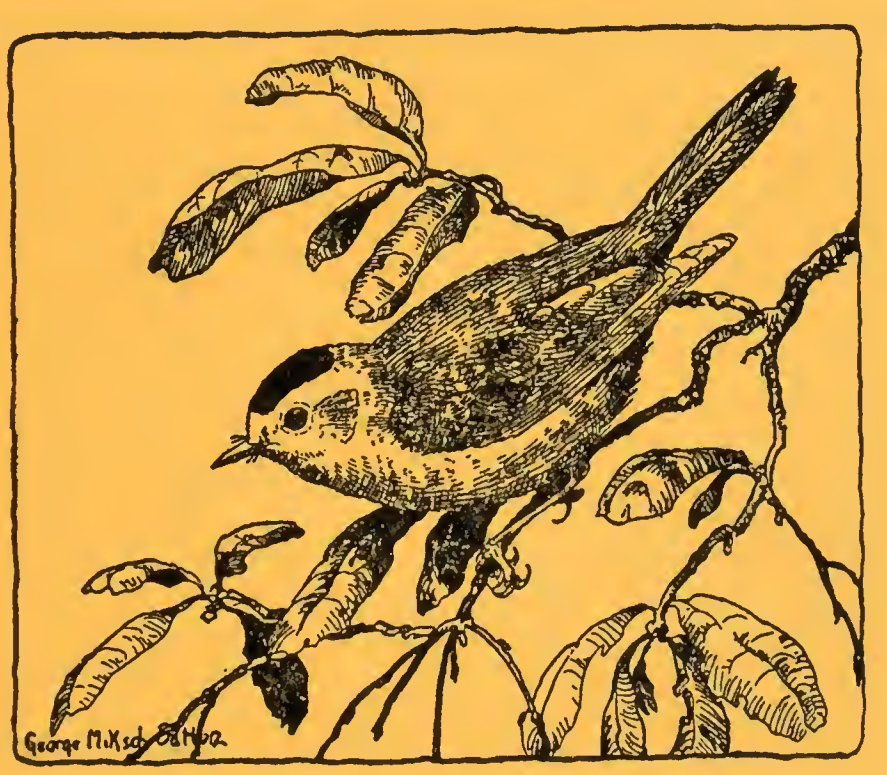

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THE WILSON BULLETIN

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KING EIDER *(Somateria spectabilis)* MATED WITH COMMON EIDER *(S. mollissima)*

A male King Eider stationed near his mate, an incubating female Common Eider; photographed by Olin Sewall Pettingill, Jr., on May 26, 1958, in Northwest Iceland.

KING EIDERS MATED WITH COMMON EIDERS IN ICELAND

BY OLIN SEWALL PETTINGILL, JR.

The Common Eider (*Somateria mollissima*) is one of Iceland's most abundant birds, with an estimated breeding population of a half million individuals (see Pettingill, 1959). The majority nest in colonies whose sizes range from a few pairs to many hundreds. From May 24 to 27, 1958, it was my good fortune to study and film one of the largest colonies (5,000 nests), situated on the farm of Gisli Vagnsson, along the Dyrafjördur in Northwest Iceland. Egg-laying at this time was virtually completed, with incubation just getting under way.

In my earlier paper (*op. cit.*) I have described the colony and pointed out that the males were present, each one stationed close to a nest while his mate sat on it. Many nests were near together—in a few cases as close as two feet, with the result that there was marked hostility among the guarding males. Presumably the males departed from the colony after the first ten days of incubation as they did on the Inner Farne (Tinbergen, 1958), an island off the northeast coast of England.

Before I visited the Vagnsson colony, Dr. Finnur Gudmundsson, Curator in the Natural History Museum at Reykjavik, told me that I should expect to find from one to several male King Eiders (*S. spectabilis*) mated with female Common Eiders. He had noted many mixed pairs himself in various Iceland colonies and once published an account of his observations (Gudmundsson, 1932:96–97). He went on to say that such matings are of "frequent occurrence" in Iceland and have been known about since the 18th Century. Farmers formerly regarded a male King Eider in a colony as an aberrant male Common Eider with the status of "king." Interestingly, Dr. Gudmundsson had never seen a male Common Eider paired with a female King Eider and had no authoritative report of any such instance.

The presence of these peculiarly mixed pairs in Iceland is remarkable as the island lies outside the breeding range of the King Eider. There is no substantiated evidence of a pure *spectabilis* pair ever having bred in Iceland. The species does, however, visit the coast of Iceland regularly in the winter, though never in large numbers. Practically all records refer to single birds, mostly adult males, in company with Common Eiders. It is not impossible, of course, that a few female and immature male King Eiders also occur in winter, but, owing to the similarity of their respective plumages to those of female and immature male Common Eiders, they are overlooked.

For the phenomenon of mixed pairs in Iceland, Dr. Gudmundsson has the following explanation: If, toward the end of winter, a visiting male King Eider pairs with a female Common Eider from Iceland, the male thereafter

accompanies the female, eventually following her to the nesting colony and remaining with her. On the other hand, if a male Common Eider from Iceland pairs with a female King Eider, say, from Greenland, the male follows her to Greenland. The basis of Dr. Gudmundsson's explanation is that, after pair formation, the male follows the female to her point of origin, wherever it may be. Considerable strength is given this assumption by Hochbaum's generalized statement (1944:62) that among ducks in the Delta Marsh (Manitoba, Canada) it is the initiative of the female that leads the pair to the breeding area.

Dr. Gudmundsson's prediction that I should find mixed pairs in the Vagnsson colony was borne out soon after my arrival for I discovered altogether two male King Eiders in normal, fully adult plumage. Each sat close to an incubating female, obviously a normal Common Eider, in a different part of the colony. Their nests were closely surrounded by other nests belonging to pure pairs of Common Eiders. The presence of the King Eiders was "an old story" to Gisli Vagnsson. The colony had been in existence since 1912, and for as long as he could remember there had always been at least one *kongur* every nesting season.

On watching the two King Eiders for short periods during the course of my visit, I became impressed with the similarity of their behavior to the behavior of neighboring male Common Eiders. Both Kings showed aggression, as did the male Commons, making vigorous attacks on near-by males, and occasionally grasping an opponent by the head, neck, wings, or tail. Both Kings were themselves attacked and grasped. A lively fight between a King and a Common sometimes took place, during which both contestants bit and thrashed each other, but neither one emerged the worse for the encounter. I could see only one difference in the behavior of the two Kings. One seemed far more aggressive by attacking several male Commons in succession at points as far away from the nest as 10 to 15 feet. I judged this behavior to be the result of his greater intolerance of adjacent males.

The fact that the two King Eiders adjusted themselves to the colony is notable since the species does not nest in colonies on its home grounds. In Greenland, for instance, the King Eider never gathers in colonies (Salomonsen, 1950–51:132–133). A natural expectation would be that a species without adaptation to colonial life could not tolerate the competition or crowding imposed by the proximity of so many nesting pairs.

Despite the frequency of mixed pairs in Iceland over a period of many years, even centuries, no *spectabilis* characters are discernible in the present population of Common Eiders. All the males which I saw in the Vagnsson colony and elsewhere were apparently pure *mollissima*. Only one hybrid specimen is known to have been taken in the country. This is a male (now in the Museum of Natural History) shot in the bay just outside Reykjavik about

1929. Further data are unavailable because it was recovered as a mounted bird in a school collection where it had been for several years. The specimen shows a blending of the characters of both species, though the *spectabilis* characters are more conspicuous. Two *mollissima* × *spectabilis* hybrids were taken in Greenland in 1894 and 1906, respectively, and later described by Krabbe (1926). Like the Iceland specimen, they too showed a blending of characters of both species. To the best of my knowledge, no other hybrid of these two species has ever been taken anywhere.

On the basis of the evidence at hand I can only conclude that offspring of mixed pairs of Common and King Eiders are rarely produced, and that in all probability the few hybrids which do result are sterile.

Literature Cited

Gudmundsson, F.
1932 Beobachtungen an isländischen Eiderenten (Somateria m. mollissima). *Sonderdruck aus Beiträge zur Fortpflanzungsbiologie der Vögel*, 8:85–97.

Hochbaum, H. A.
1944 The Canvasback on a Prairie Marsh. Amer. Wildl. Inst., Washington, D. C. 201 pp.

Krabbe, T. N.
1926 Two Supposed Hybrids between the Two Greenland Species of Eider. *Verh. VI. Intern. Ornith. Kong.*, pp. 173–180.

Pettingill, O. S., Jr.
1959 Puffins and Eiders in Iceland. *Maine Field Nat.*, 15:58–71.

Salomonsen, F.
1950–51 The Birds of Greenland. Ejnar Munksgaard, Copenhagen, Denmark.

Tinbergen, N.
1958 Curious Naturalists. Country Life Limited, London.

UNIVERSITY OF MICHIGAN BIOLOGICAL STATION, PELLSTON, MICHIGAN, JULY 27, 1959

FORTY YEARS OF SPRING MIGRATION IN SOUTHERN CONNECTICUT

BY ARETAS A. SAUNDERS

For many years it has been my habit to rise early on spring mornings, and spend the early hours keeping track of the bird migration. In earlier years this was in the vicinity of New Haven, Connecticut. Later it was in Norwalk, and finally in Fairfield. All of these are about the same latitude along the coast. Observations first began in 1902 but are rather incomplete in the earlier years. From 1908 to 1913 I was elsewhere, but from 1914 to 1949 the records are quite complete.

I will not assert that I always found each species on the day its first individuals arrived. I know that in some cases I did not, for others informed me, at times, that they had found certain species a day or two before I did. I have used some of these earlier dates whenever I was sure that they were reliable. For example, Mr. Frank Novak, warden of the Birdcraft Sanctuary in Fairfield, frequently found the first House Wren a day or two before I did.

In finding birds I frequently used my knowledge of bird songs. It is much easier to hear a bird sing, and identify it by the song than it is to get a clear view of it in just the right light to identify it. I do not mean, however, that I relied on song in all cases. The Veery, for example, usually arrives several days before it begins to sing. If a song was unrecognizable, or that of a rare species, I made it a practice to see the bird.

In general, when a species arrives its numbers begin to increase, and it is soon common. Occasionally a single individual arrives long before the rest of its species. I found this true on two occasions with the White-eyed Vireo, and once with the Indigo Bunting. In each case it was many days before another individual appeared. Both are birds that arrive in May, and in each case the early individuals arrived in April.

My data on the arrivals of shore and water birds are not as complete, largely because such birds were scarce in the earlier days. When the Migratory Bird Treaty Act (1916) was put into effect, and the shore birds were all protected, the increase in these species was remarkable. The case of the Laughing Gull illustrates this. When a species is common, its migration dates are likely to be earlier than when it is scarce. This gull was very rare when "The Birds of Connecticut" (Sage and Bishop, 1913) was published. I saw my first one in 1916. By 1919 I began recording its arrival in spring migration. For the first 11 years thereafter its date of arrival averaged between May 6 and 7. For the entire period, 1919 to 1949, it averaged about April 26. But for the last 16 years the average was between April 16 and 17. These last years are probably more nearly the correct time.

The two species of orioles also indicate the extent to which the abundance of a species produces earlier dates. The Baltimore Oriole is exceedingly common, but the Orchard Oriole rather uncommon. In certain years I have found both species arriving on the same day, but the average arrival of the Baltimore Oriole is about May 5, whereas that of the Orchard Oriole is between May 9 and 10.

I have listed in Tables 1–3 all of the species that I am including in this paper. They are divided into lists of arrivals of summer residents; departures of winter visitors; and arrivals and departures of transient species. In each case the earliest, latest and average dates are given. This does not include all of the birds observed through the period, for there are resident species that do not migrate, and many species too rare to give definite dates on migration.

One of the interesting things about this study is the difference between different years, some being early, others late, and still others about average. In order to study these years and compare them I have selected 50 common summer resident species and arranged them in order of their average dates of arrival, from the Common Grackle in early March, to the Yellow-billed Cuckoo in the latter part of May (Table 4).

When one has a series of dates of arrival of any given species and adds them up and determines the average date of arrival, that date is likely to be a fraction. It would be incongruous to speak of the average date of arrival of the Yellow Warbler, for example, as May 1.52. All averages were calculated to two decimal places, however, to determine the order of listing of species (Table 4), especially of those whose average arrivals were on the same day. However, each fractional amount was "rounded-off" to the nearest date for Tables 1–4.

There is not a species whose average arrival is in March, that has not been known to occur, sometimes, in the winter. There is usually, however, some means of indicating the difference between migrating birds and wintering ones. Wintering birds generally occur in certain localities, but migrating ones are likely to be in new places. It is because of the lack of anything definite to distinguish winter birds from migrants that I left the Song Sparrow out of Table 4. Numbers of the birds spend the winter, but they are likely to sing in January or February, before migration begins; and while there are indications of migration early in March, I did not feel too sure of the dates.

From the data on average arrivals I have constructed diagrams, plotting the species horizontally, and the dates of arrivals vertically, the earlier dates at the bottom. Thus, the 50 species make a line that gradually rises from left to right.

Then, plotting the actual dates of arrival for any one year forms a very irregular line. Early dates come below the line of average arrivals, and late dates above it. I have thus made diagrams for all of the years for which I have

records, and I am using four of these as illustrations (Figs. 1–4). The four selected are 1938, 1940, 1917 and 1923. 1938 (Fig. 1) is the year of earliest arrivals in my records. 1940 (Fig. 2) is the most uniformly late year. 1917 (Fig. 3) is an unusual year, actually latest in total figures, but not uniformly so, and 1923 (Fig. 4) is nearest the calculated average.

For each year I determined the number of days and fractions of days that each species was early or late, added the late dates and the early dates, subtracted the smaller result from the larger, which determined whether the year was early or late, and divided the result by 50, which gave me the average number of days or fractions of a day that the species were early or late.

By this means I determined that the 50 species averaged 6.15 days early in 1938 and 3.55 days late in 1940. In 1923 they were 0.20 days early, and in the erratic year of 1917 they averaged 5.38 days late.

The year 1917 was a most remarkable one. In March and April the first 19 species of the 50 summer residents averaged a little less than 1 day late, but the remaining 31 species that had average arrivals in May were 7.98 days late. The weather in the early days of May was cold, raw and more or less rainy. I searched for birds at a time when one normally expects them to be arriving in numbers. On May 3 I found one American Redstart, but not another till May 15. On May 5 there was one Catbird and one Ovenbird. A Bobolink appeared on May 9, and a Veery on May 10. Then, on May 12, birds began appearing in numbers. From then until the 19th birds were everywhere. They were mostly warblers and thrushes and were down low in the shrubbery but were easily seen. Transient species were even later than the summer residents. Ruby-crowned Kinglets were present till May 18. Parula, Magnolia, Blackburnian and Bay-breasted Warblers remained till June 2, Tennessee Warblers till June 9, and Blackpoll Warblers to June 10. I have previously published something about the relation of these birds to tent caterpillars in this particular spring (1920. *Auk*, 37:312).

In the springs of 1923 and 1924 the arrival dates came close to the average. Actually, 1924 figured closer to the average, but the figures, species by species, were more erratic than 1923.

I hoped that the figures obtained would give some data on cycles of early and late years. While they did not show anything very definite, they did show that there were more late years in the early part of the period, and early years in the latter part. In the period from 1902 to 1934, the years for which I have records averaged 0.99 days late. From 1935 to 1949, the years averaged 1.48 days early. There were 15 late years and seven early ones in the first period, and three late ones and 12 early ones in the second period.

I thought that there might be some correlation between bird migrations and the growth of trees. I knew of only one tree that had been cut at a date that

was definite. A large white oak, that I had passed by many times, was cut down in the fall of 1956. When I examined its stump the outer rings were so small that I needed a lens to count them. There was one ring definitely wider than the others, and counting back from the outermost ring that ring proved to be 1938. But in the rings earlier than that I could find nothing definite.

TABLE 1

ARRIVALS OF SUMMER RESIDENTS

Species	No. of Years	Average	Earliest	Latest
Green Heron (*Butorides virescens*)	34	Apr. 27	Apr. 15, 1920	May 8, 1931
Black-crowned Night Heron (*Nycticorax nycticorax*)	34	Apr. 10	Mar. 25, 1945	Apr. 24, 1935
Wood Duck (*Aix sponsa*)	14	Mar. 25	Feb. 28, 1946	Apr. 25, 1925
Broad-winged Hawk (*Buteo platypterus*)	15	May 1	Apr. 17, 1925	May 16, 1947
Clapper Rail (*Rallus longirostris*)	19	May 15	May 2, 1930	May 28, 1922
Killdeer (*Charadrius vociferus*)	34	Mar. 23	Mar. 13, 1938	Apr. 3, 1940
Spotted Sandpiper (*Actitis macularia*)	40	May 2	Apr. 25, 1916	May 14, 1924
Mourning Dove (*Zenaidura macroura*)	30	Mar. 18	Feb. 19, 1944	Apr. 6, 1924
Yellow-billed Cuckoo (*Coccyzus americanus*)	28	May 18	May 7, 1949	June 1, 1920
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	30	May 13	May 1, 1928	May 31, 1921
Whip-poor-will (*Caprimulgus vociferus*)	10	Apr. 28	Apr. 22, 1914	May 6, 1931
Common Nighthawk (*Chordeiles minor*)	33	May 15	May 5, 1919	May 27, 1927
Chimney Swift (*Chaetura pelagica*)	39	Apr. 28	Apr. 12, 1947	May 6, 1931
Ruby-throated Hummingbird (*Archilochus colubris*)	29	May 15	May 3, 1938	May 26, 1929
Belted Kingfisher (*Megaceryle alcyon*)	34	Mar. 23	Mar. 13, 1938	Apr. 3, 1940
Yellow-shafted Flicker (*Colaptes auratus*)	37	Mar. 25	Mar. 12, 1919	Apr. 7, 1940
Eastern Kingbird (*Tyrannus tyrannus*)	40	May 7	Apr. 30, 1940	May 18, 1917
Great Crested Flycatcher (*Myiarchus crinitus*)	35	May 9	Apr. 30, 1933	May 22, 1931
Eastern Phoebe (*Sayornis phoebe*)	40	Mar. 24	Mar. 12, 1921	Apr. 8, 1946
Least Flycatcher (*Empidonax minimus*)	35	May 2	Apr. 27, 1915	May 12, 1917
Eastern Wood Pewee (*Contopus virens*)	39	May 18	May 12, 1937	June 2, 1906
Rough-winged Swallow (*Stelgidopteryx ruficollis*)	30	Apr. 22	Apr. 3, 1938	May 10, 1917
Barn Swallow (*Hirundo rustica*)	40	Apr. 18	Apr. 3, 1938	Apr. 28, 1945
Purple Martin (*Progne subis*)	13	Apr. 28	Apr. 3, 1938	May 5, 1932
Fish Crow (*Corvus ossifragus*)	36	Mar. 26	Mar. 5, 1921	Apr. 9, 1940
House Wren (*Troglodytes aedon*)	39	Apr. 25	Apr. 16, 1922	May 4, 1940
Long-billed Marsh Wren (*Telmatodytes palustris*)	21	May 18	Apr. 30, 1941	May 26, 1945
Catbird (*Dumetella carolinensis*)	40	May 2	Apr. 25, 1921	May 6, 1931

TABLE 1 (Continued)

Species	No. of Years	Average	Earliest	Latest
Brown Thrasher (*Toxostoma rufum*)	40	Apr. 22	Apr. 7, 1929	May 4, 1940
Robin (*Turdus migratorius*)	40	Mar. 10	Feb. 20, 1946	Mar. 22, 1926
Wood Thrush (*Hylocichla mustelina*)	40	May 2	Apr. 27, 1939	May 13, 1917
Veery (*Hylocichla fuscescens*)	40	May 6	Apr. 30, 1933	May 15, 1920
Eastern Bluebird (*Sialia sialis*)	40	Mar. 9	Feb. 22, 1939	Mar. 23, 1928
White-eyed Vireo (*Vireo griseus*)	35	May 7	Apr. 23, 1938	May 19, 1917
Yellow-throated Vireo (*Vireo flavifrons*)	35	May 6	Apr. 30, 1938	May 17, 1917
Red-eyed Vireo (*Vireo olivaceus*)	40	May 11	May 2, 1906	May 19, 1917
Warbling Vireo (*Vireo gilvus*)	35	May 9	May 1, 1938	May 22, 1948
Black-and-white Warbler (*Mniotilta varia*)	36	Apr. 25	Apr. 18, 1936	Apr. 30, 1922
Worm-eating Warbler (*Helmitheros vermivorus*)	33	May 12	May 4, 1944	May 22, 1948
Blue-winged Warbler (*Vermivora pinus*)	40	May 4	Apr. 28, 1945	May 13, 1917
Yellow Warbler (*Dendroica petechia*)	40	May 2	Apr. 26, 1929	May 15, 1917
Black-throated Green Warbler (*Dendroica virens*)	38	Apr. 30	Apr. 24, 1922	May 11, 1917
Chestnut-sided Warbler (*Dendroica pensylvanica*)	39	May 5	Apr. 28, 1938	May 17, 1917
Prairie Warbler (*Dendroica discolor*)	38	May 4	Apr. 27, 1938	May 18, 1917
Ovenbird (*Seiurus aurocapillus*)	40	May 2	Apr. 27, 1945	May 7, 1920
Louisiana Waterthrush (*Seiurus motacilla*)	35	Apr. 18	Apr. 6, 1928	Apr. 25, 1924
Yellowthroat (*Geothlypis trichas*)	38	May 4	Apr. 28, 1938	May 16, 1937
Yellow-breasted Chat (*Icteria virens*)	37	May 9	May 3, 1929	May 18, 1917
Hooded Warbler (*Wilsonia citrina*)	32	May 8	May 1, 1938	May 22, 1948
American Redstart (*Setophaga ruticilla*)	38	May 3	Apr. 30, 1938	May 15, 1948
Bobolink (*Dolichonyx oryzivorus*)	31	May 6	Apr. 28, 1935	May 10, 1925
Eastern Meadowlark (*Sturnella magna*)	37	Mar. 21	Mar. 9, 1922	Mar. 31, 1940
Redwinged Blackbird (*Agelaius phoeniceus*)	40	Mar. 9	Feb. 19, 1939	Mar. 25, 1920
Orchard Oriole (*Icterus spurius*)	35	May 10	Apr. 30, 1938	May 22, 1947
Baltimore Oriole (*Icterus galbula*)	40	May 5	Apr. 30, 1938	May 12, 1917
Common Grackle (*Quiscalus quiscula*)	40	Mar. 8	Feb. 24, 1925	Mar. 26, 1916
Brown-headed Cowbird (*Molothrus ater*)	40	Mar. 26	Mar. 13, 1946	Apr. 7, 1947
Scarlet Tanager (*Piranga olivacea*)	40	May 8	Apr. 30, 1938	May 19, 1917
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	40	May 5	Apr. 30, 1935	May 15, 1917
Indigo Bunting (*Passerina cyanea*)	39	May 15	Apr. 22, 1941	May 23, 1917
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	40	Apr. 19	Apr. 8, 1915	Apr. 29, 1937
Grasshopper Sparrow (*Ammodramus savannarum*)	27	May 4	Apr. 28, 1925	May 16, 1931
Henslow's Sparrow (*Passerherbulus henslowii*)	7	May 5	Apr. 28, 1941	May 9, 1936

TABLE 1 (Continued)

Species	No. of Years	Average	Earliest	Latest
Sharp-tailed Sparrow (*Ammospiza caudacuta*)	30	May 20	May 8, 1938	May 29, 1930
Seaside Sparrow (*Ammospiza maritima*)	31	May 17	May 4, 1938	May 30, 1931
Vesper Sparrow (*Pooecetes gramineus*)	40	Apr. 1	Mar. 15, 1920	Apr. 15, 1940
Chipping Sparrow (*Spizella passerina*)	38	Apr. 13	Apr. 1, 1945	Apr. 21, 1932
Field Sparrow (*Spizella pusilla*)	39	Mar. 27	Mar. 16, 1929	Apr. 6, 1934
Song Sparrow (*Melospiza melodia*)	36	Mar. 6	Feb. 25, 1930	Mar. 17, 1934

TABLE 2

DEPARTURES OF WINTER VISITORS

Species	No. of Years	Average	Earliest	Latest
Horned Grebe (*Podiceps auritus*)	20	Apr. 24	Apr. 15, 1924	May 15, 1933
Greater Scaup (*Aythya marila*)	23	Apr. 18	Mar. 30, 1935	May 12, 1917
Common Goldeneye (*Bucephala clangula*)	33	Apr. 9	Mar. 12, 1927	May 18, 1940
Bufflehead (*Bucephala albeola*)	21	Apr. 19	Mar. 10, 1928	May 12, 1917
Oldsquaw (*Clangula hyemalis*)	32	May 11	Apr. 17, 1918	May 30, 1941
White-winged Scoter (*Melanitta deglandi*)	27	May 18	Apr. 5, 1924	June 1, 1936
Surf Scoter (*Melanitta perspicillata*)	17	Apr. 29	Apr. 10, 1937	May 26, 1922
Common Merganser (*Mergus merganser*)	21	Apr. 10	Apr. 2, 1921	May 3, 1947
Red-breasted Merganser (*Mergus serrator*)	22	May 11	Apr. 15, 1928	May 13, 1919
Purple Sandpiper (*Erolia maritima*)	6	May 9	Apr. 3, 1938	June 5, 1943
Great Black-backed Gull (*Larus marinus*)	18	Apr. 13	Mar. 18, 1931	May 4, 1947
Horned Lark (*Eremophila alpestris*)	14	Mar. 19	Feb. 27, 1943	Apr. 8, 1939
Red-breasted Nuthatch (*Sitta canadensis*)	9	Apr. 14	Mar. 25, 1949	May 7, 1932
Brown Creeper (*Certhia familiaris*)	28	Apr. 22	Apr. 6, 1929	May 19, 1917
Golden-crowned Kinglet (*Regulus satrapa*)	22	Apr. 23	Apr. 3, 1921	May 16, 1917
Myrtle Warbler (*Dendroica coronata*)	35	May 18	May 7, 1918	May 28, 1927
Slate-colored Junco (*Junco hyemalis*)	40	Apr. 29	Apr. 19, 1915	May 17, 1917
Tree Sparrow (*Spizella arborea*)	37	Apr. 2	Mar. 12, 1918	Apr. 25, 1940
Snow Bunting (*Plectrophenax nivalis*)	13	Feb. 25	Feb. 12, 1937	Mar. 10, 1934

Table 3

Arrivals and Departures of Transients

Species	No. of Years	Arrivals			Departures		
		Average	Earliest	Latest	Average	Earliest	Latest
Common Loon (*Gavia immer*)	27	Apr. 13	Mar. 28, 1936	Apr. 28, 1936	May 24	May 1, 1929	June 20, 1942
Pied-billed Grebe (*Podilymbus podiceps*)	13	Apr. 3	Mar. 20, 1934	Apr. 19, 1917	Apr. 28	Apr. 15, 1940	May 12, 1928
Great Blue Heron (*Ardea herodias*)	25	Apr. 7	Mar. 12, 1949	Apr. 17, 1927	May 19	May 4, 1944	May 31, 1942
Canada Goose (*Branta canadensis*)	12	Mar. 31	Mar. 7, 1946	Apr. 17, 1918	May 13	May 1, 1941	June 5, 1938
Ring-necked Duck (*Aythya collaris*)	12	Mar. 16	Mar. 1, 1938	Apr. 3, 1942	Apr. 26	Apr. 11, 1942	May 3, 1939
Osprey (*Pandion haliaetus*)	27	Apr. 11	Mar. 25, 1944	Apr. 26, 1922	May 10	Apr. 30, 1938	May 28, 1927
Semipalmated Plover (*Charadrius semipalmatus*)	32	May 13	May 3, 1924	May 29, 1920	June 3	May 28, 1921	June 14, 1939
Black-bellied Plover (*Squatarola squatarola*)	25	May 15	Apr. 28, 1946	May 24, 1930	June 5	May 28, 1922	June 17, 1939
Ruddy Turnstone (*Arenaria interpres*)	33	May 21	May 8, 1938	May 30, 1925	June 5	May 29, 1926	June 16, 1939
Solitary Sandpiper (*Tringa solitaria*)	26	May 10	Apr. 29, 1905	May 18, 1936	May 17	May 14, 1906	May 27, 1917
Greater Yellowlegs (*Totanus melanoleucus*)	25	Apr. 23	Apr. 8, 1934	Apr. 30, 1947	June 2	May 20, 1921	June 13, 1946
Knot (*Calidris canutus*)	22	May 25	May 4, 1938	May 31, 1940	June 2	May 30, 1933	June 12, 1939
Least Sandpiper (*Erolia minutilla*)	35	May 12	May 2, 1941	May 22, 1943	June 1	May 27, 1924	June 15, 1946
Dunlin (*Erolia alpina*)	15	May 21	May 7, 1942	May 26, 1946	May 31	May 27, 1933	June 17, 1946
Short-billed Dowitcher (*Limnodromus griseus*)	18	May 21	May 4, 1938	May 27, 1942	May 29	May 22, 1937	June 6, 1931
Semipalmated Sandpiper (*Ereunetes pusillus*)	32	May 16	Apr. 30, 1928	May 25, 1943	June 11	June 1, 1918	June 20, 1939
Sanderling (*Crocethia alba*)	27	May 19	May 7, 1942	May 28, 1927	June 6	May 30, 1944	June 7, 1939
Laughing Gull (*Larus atricilla*)	24	Apr. 21	Apr. 9, 1938	May 2, 1932	—	—	—
Bonaparte's Gull (*Larus philadelphia*)	18	May 5	Apr. 4, 1948	May 19, 1921	May 27	May 22, 1948	June 13, 1927
Common Tern (*Sterna hirundo*)	28	May 14	May 5, 1932	May 25, 1925	June 3	May 26, 1924	June 13, 1931
Roseate Tern (*Sterna dougallii*)	17	May 14	May 5, 1932	May 26, 1949	May 28	May 21, 1939	June 21, 1936
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	12	Apr. 11	Mar. 30, 1927	Apr. 19, 1923	Apr. 29	Apr. 20, 1923	May 13, 1917
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	11	May 20	May 18, 1937	May 25, 1945	June 1	May 27, 1941	June 11, 1944
Tree Swallow (*Iridoprocne bicolor*)	35	Apr. 8	Mar. 24, 1921	Apr. 19, 1931	May 22	May 6, 1942	May 31, 1925
Bank Swallow (*Riparia riparia*)	14	May 3	Apr. 18, 1936	May 12, 1925	May 21	May 15, 1921	May 31, 1937
Cliff Swallow (*Petrochelidon pyrrhonota*)	12	May 1	Apr. 30, 1938	May 12, 1917	May 23	May 16, 1936	May 30, 1917
Winter Wren (*Troglodytes troglodytes*)	15	Mar. 29	Mar. 1, 1946	Apr. 10, 1943	Apr. 23	Apr. 17, 1927	May 5, 1928

Species	No. of Years	Arrivals			Departures		
		Average	Earliest	Latest	Average	Earliest	Latest
Hermit Thrush (*Hylocichla guttata*)	32	Apr. 14	Mar. 29, 1929	Apr. 30, 1928	Apr. 28	Apr. 20, 1938	May 19, 1917
Swainson's Thrush (*Hylocichla ustulata*)	34	May 13	May 2, 1914	May 23, 1924	May 22	May 18, 1918	May 31, 1936
Gray-cheeked Thrush (*Hylocichla minima*)	27	May 19	May 13, 1949	May 25, 1927	May 24	May 17, 1914	May 30, 1930
Ruby-crowned Kinglet (*Regulus calendula*)	36	Apr. 15	Mar. 29, 1924	Apr. 17, 1940	May 3	Apr. 27, 1949	May 19, 1917
Solitary Vireo (*Vireo solitarius*)	33	Apr. 25	Apr. 20, 1927	May 4, 1915	May 7	May 1, 1928	May 24, 1917
Tennessee Warbler (*Vermivora peregrina*)	30	May 17	May 8, 1927	May 23, 1935	May 25	May 17, 1922	June 9, 1917
Nashville Warbler (*Vermivora ruficapilla*)	34	May 6	Apr. 27, 1925	May 18, 1917	May 19	May 11, 1922	May 26, 1930
Parula Warbler (*Parula americana*)	38	May 5	Apr. 27, 1925	May 11, 1917	May 29	May 21, 1906	June 6, 1935
Magnolia Warbler (*Dendroica magnolia*)	36	May 10	May 5, 1914	May 17, 1917	May 26	May 11, 1918	June 2, 1917
Black-throated Blue Warbler (*Dendroica caerulescens*)	36	May 8	May 2, 1941	May 17, 1917	May 22	May 13, 1946	June 1, 1945
Blackburnian Warbler (*Dendroica fusca*)	36	May 14	May 2, 1914	May 24, 1932	May 24	May 14, 1919	June 2, 1917
Bay-breasted Warbler (*Dendroica castanea*)	27	May 19	May 7, 1932	May 25, 1931	May 24	May 14, 1919	June 2, 1917
Blackpoll Warbler (*Dendroica striata*)	38	May 14	May 7, 1938	May 19, 1917	June 5	May 29, 1914	June 13, 1927
Pine Warbler (*Dendroica pinus*)	30	Apr. 15	Apr. 1, 1921	Apr. 27, 1940	Apr. 23	Apr. 17, 1943	May 7, 1939
Palm Warbler (*Dendroica palmarum*)	36	Apr. 17	Apr. 3, 1938	May 2, 1934	May 1	Apr. 18, 1936	May 13, 1917
Northern Waterthrush (*Seiurus noveboracensis*)	38	May 7	Apr. 29, 1945	May 16, 1920	May 26	May 18, 1931	June 8, 1945
Mourning Warbler (*Oporornis philadelphia*)	14	May 25	May 21, 1932	May 27, 1914	June 4	May 29, 1943	June 10, 1928
Wilson's Warbler (*Wilsonia pusilla*)	33	May 17	May 8, 1914	May 24, 1939	May 23	May 17, 1914	June 10, 1927
Canada Warbler (*Wilsonia canadensis*)	38	May 12	May 9, 1943	May 24, 1917	May 30	May 21, 1914	June 10, 1945
Rusty Blackbird (*Euphagus carolinus*)	36	Mar. 21	Mar. 2, 1930	Apr. 10, 1948	Apr. 21	Apr. 1, 1919	May 15, 1917
Savannah Sparrow (*Passerculus sandwichensis*)	34	Apr. 9	Mar. 22, 1942	Apr. 23, 1930	Apr. 30	Apr. 24, 1927	May 9, 1936
White-crowned Sparrow (*Zonotrichia leucophrys*)	12	May 13	May 8, 1932	May 19, 1941	May 17	May 13, 1934	May 20, 1941
White-throated Sparrow (*Zonotrichia albicollis*)	38	Apr. 9	Mar. 26, 1937	Apr. 23, 1918	May 16	May 6, 1918	May 29, 1917
Fox Sparrow (*Passerella iliaca*)	38	Mar. 12	Feb. 24, 1925	Apr. 2, 1927	Apr. 7	Mar. 26, 1948	Apr. 24, 1940
Swamp Sparrow (*Melospiza georgiana*)	34	Apr. 10	Mar. 22, 1942	Apr. 25, 1936	May 8	May 1, 1944	May 24, 1917

Table 4

Fifty Common Summer Residents Arranged in Order of Average Dates of Arrival

Species	Average Arrivals	Dates of First Arrivals			
		1917	1923	1938	1940
1. Common Grackle	March 8	March 15	March 3	March 8	March 18
2. Redwinged Blackbird	March 9	March 15	March 17	Feb. 26	March 16
3. Eastern Bluebird	March 9	March 12	March 3	March 12	March 16
4. Robin	March 10	March 10	March 3	March 7	March 6
5. Eastern Phoebe	March 24	March 31	March 21	March 20	April 2
6. Yellow-shafted Flicker	March 25	March 25	March 22	March 20	April 7
7. Brown-headed Cowbird	March 26	March 22	March 30	March 20	April 2
8. Field Sparrow	March 27	March 24	April 4	March 20	April 2
9. Vesper Sparrow	April 1	March 31	March 27	April 2	April 5
10. Chipping Sparrow	April 13	April 1	April 8	April 12	April 17
11. Louisiana Waterthrush	April 18	April 22	April 21	April 12	April 16
12. Barn Swallow	April 18	April 20	April 22	April 3	April 6
13. Rufous-sided Towhee	April 19	April 21	April 17	April 2	April 25
14. Brown Thrasher	April 22	April 21	April 22	April 15	May 4
15. Rough-winged Swallow	April 22	May 10	April 21	April 3	April 27
16. House Wren	April 25	April 23	April 20	April 20	May 4
17. Black-and-white Warbler	April 25	April 21	April 27	April 19	April 19
18. Green Heron	April 27	April 22	April 21	April 24	April 27
19. Chimney Swift	April 28	April 21	April 29	April 24	May 1
20. Black-throated Green Warbler	April 30	May 11	April 27	April 28	May 4
21. Yellow Warbler	May 2	May 15	May 1	April 27	May 5
22. Catbird	May 2	May 5	April 30	April 29	May 5
23. Ovenbird	May 2	May 5	May 1	April 28	May 4
24. Spotted Sandpiper	May 2	April 28	April 28	April 29	May 10
25. Least Flycatcher	May 2	May 12	May 4	May 1	May 3
26. Wood Thrush	May 2	May 12	May 4	April 28	May 4
27. American Redstart	May 3	May 3	May 1	April 30	May 7
28. Prairie Warbler	May 4	May 18	May 4	April 27	May 11
29. Blue-winged Warbler	May 4	May 13	May 2	April 29	May 7
30. Yellowthroat	May 4	May 12	May 5	April 28	May 11
31. Baltimore Oriole	May 4	May 12	May 5	April 30	May 5
32. Chestnut-sided Warbler	May 5	May 17	May 4	April 28	May 7
33. Rose-breasted Grosbeak	May 5	May 15	May 4	May 2	May 10
34. Bobolink	May 6	May 9	May 5	May 1	May 8
35. Yellow-throated Vireo	May 6	May 17	May 5	April 30	May 4
36. Veery	May 6	May 10	May 10	May 7	May 6
37. Eastern Kingbird	May 7	May 18	May 5	May 2	May 7
38. White-eyed Vireo	May 7	May 19	May 7	April 23	May 6
39. Scarlet Tanager	May 8	May 19	May 8	April 30	May 10
40. Hooded Warbler	May 8	May 26	May 5	May 1	May 11

TABLE 4 (Continued)

Species	Average Arrivals	Dates of First Arrivals 1917	1923	1938	1940
41. Great Crested Flycatcher	May 9	May 19	May 9	May 3	May 11
42. Yellow-breasted Chat	May 9	May 18	May 12	May 4	May 16
43. Orchard Oriole	May 10	May 16	May 12	April 30	May 11
44. Red-eyed Vireo	May 11	May 19	May 13	May 4	May 7
45. Black-billed Cuckoo	May 13	May 18	May 12	May 5	May 26
46. Indigo Bunting	May 15	May 23	May 20	May 6	May 19
47. Common Nighthawk	May 15	May 25	May 7	May 6	May 8
48. Ruby-throated Hummingbird	May 15	May 13	May 17	May 3	May 22
49. Eastern Wood Pewee	May 18	May 30	May 22	May 13	May 15
50. Yellow-billed Cuckoo	May 18	May 19	May 26	May 21	May 29

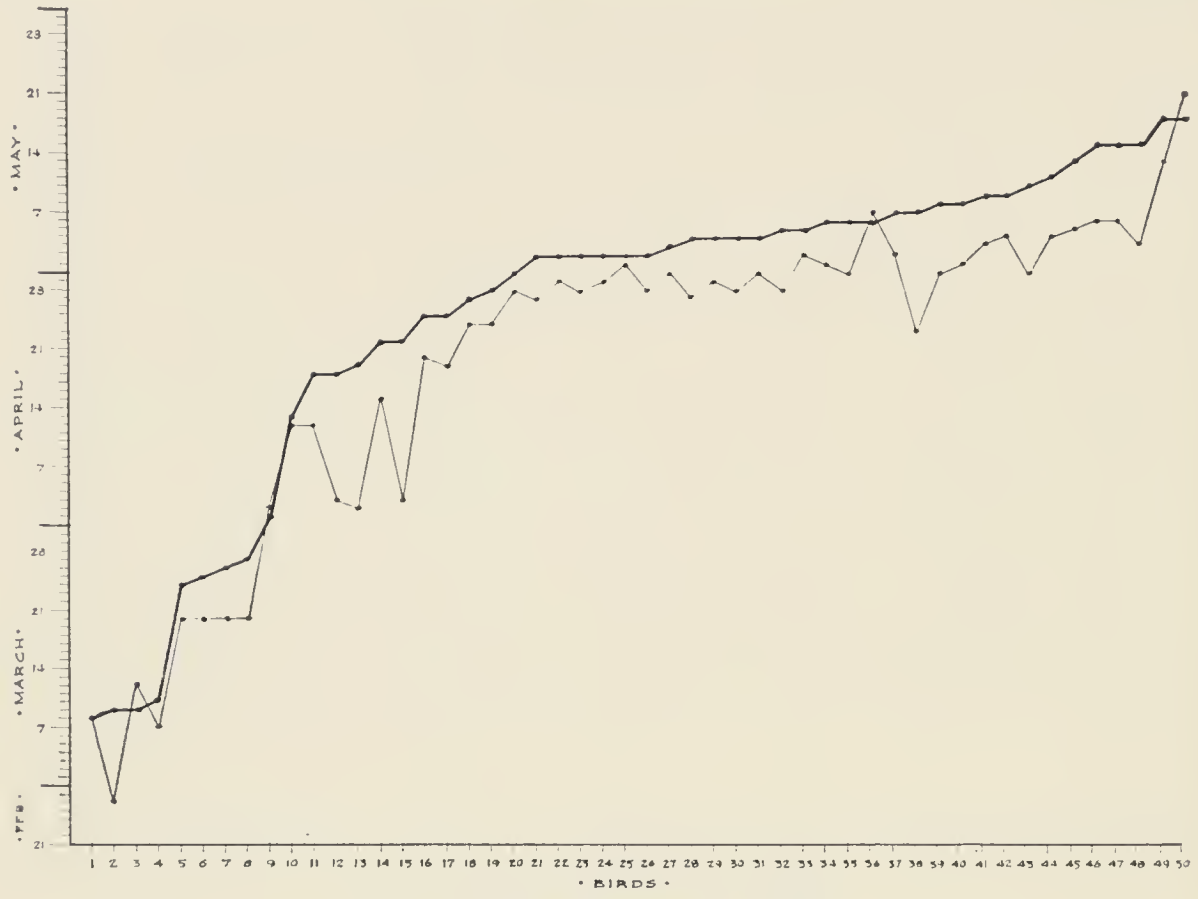


FIG. 1. Spring migration in 1938.[1]

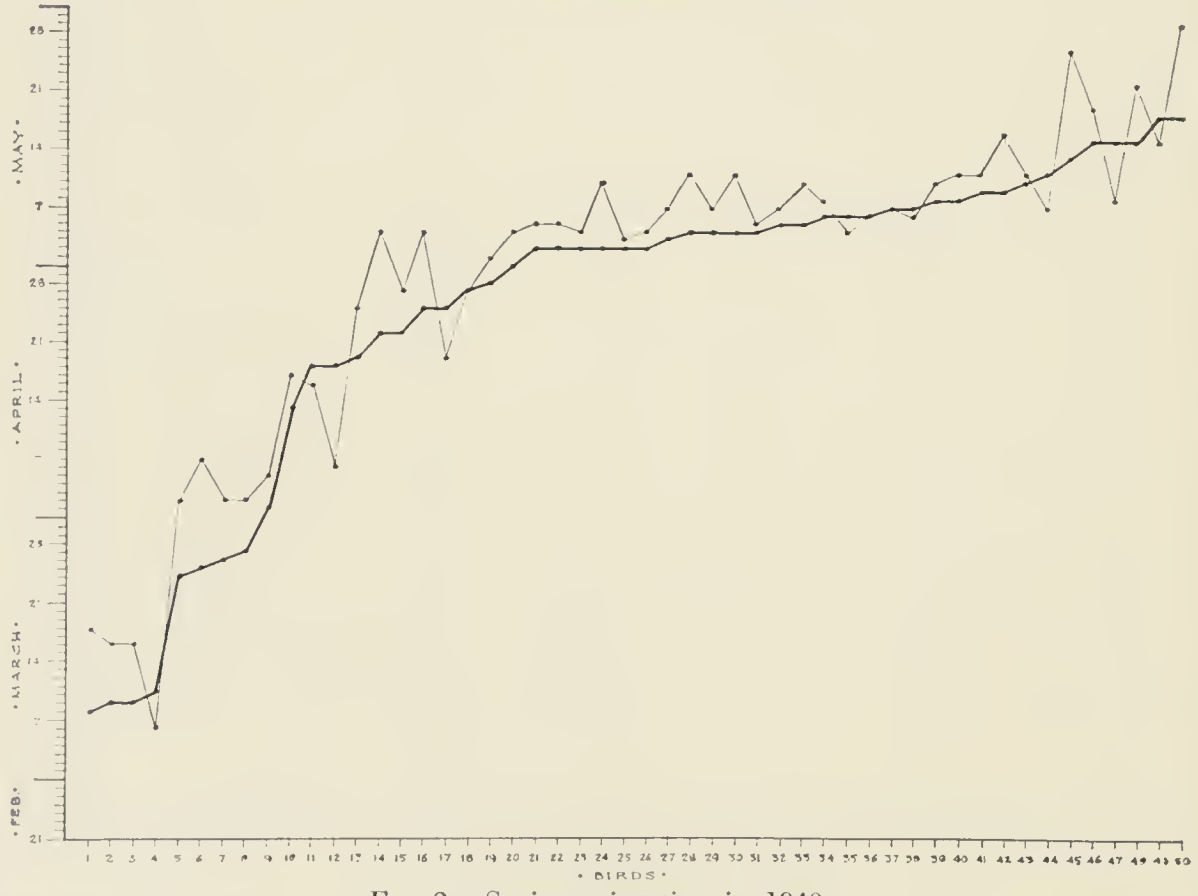


FIG. 2. Spring migration in 1940.

[1]For Figs. 1–4, the numbers 1–50 represent the common summer residents listed in Table 4; the thin line designates dates of arrival for the particular year, the thick line the dates of average arrival (Table 4).

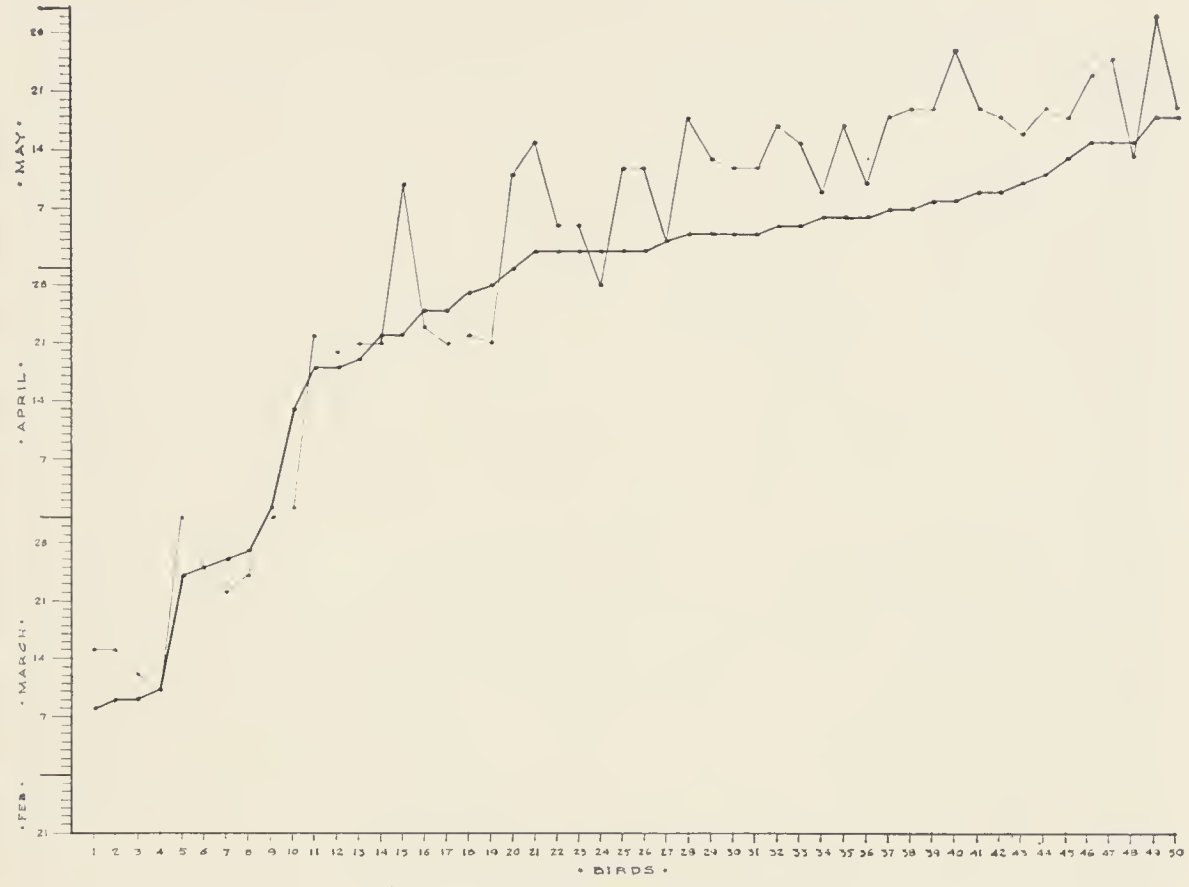


FIG. 3. Spring migration in 1917.

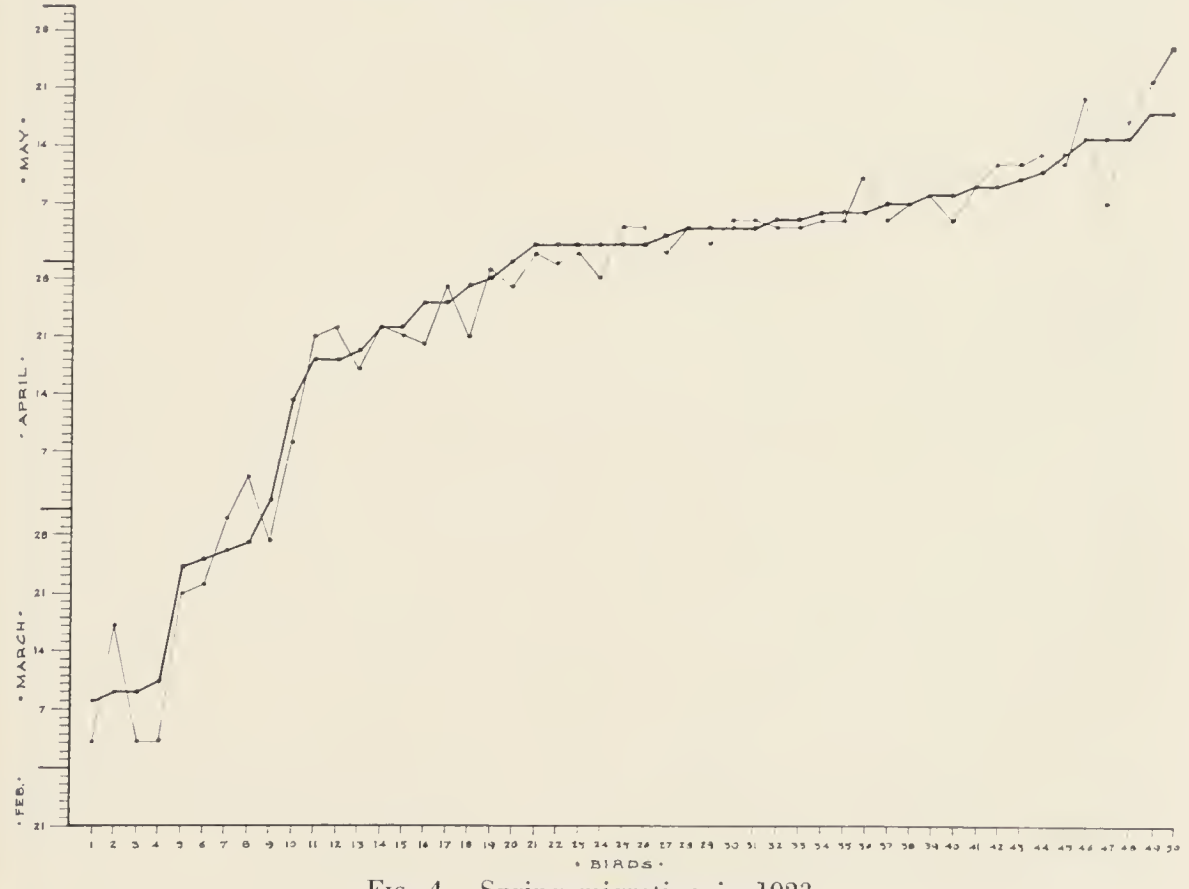


FIG. 4. Spring migration in 1923.

P. O. BOX 141, CANAAN, CONNECTICUT, JUNE 27, 1957

AN AUDIO TECHNIQUE FOR THE STUDY OF NOCTURNAL MIGRATION OF BIRDS

BY RICHARD R. GRABER AND WILLIAM W. COCHRAN

THE long-standing interest of ornithologists in nocturnal migration has, if anything, increased in recent years with the perfection of techniques for direct study of the phenomenon.

As early as 1880, Scott (1881) pointed out the potential value of lunar observations in the study of migration, and subsequently many workers have utilized the technique (see Carpenter, 1906; Lowery, 1951, for history and bibliography). Howell, Laskey, and Tanner (1954), and others have studied migration in the light of ceilometer beams.

Radar is a very promising tool (Sutter, 1957*a*, 1957*b*), and its use for study of migration is still in a development stage.

A technique which has been used almost as widely as that of lunar observation is the audio method based on detection of flight calls (Libby, 1899; Kopman, 1904; Tyler, 1916; Ball, 1952; and others).

Recently, Lowery and Newman (1955) summarized current knowledge on the subject of direct observation of nocturnal migration. These authors applauded the work of Ball (1952) but pointed out the basic limitations of the audio technique which he used. There are three principal shortcomings of the technique as used by Ball and others: (1) With the unaided ear, migrants can be heard only when they are flying low. Ball (1952:49) calculated that he could detect calls of *Hylocichla* thrushes to a maximum elevation of 1500 feet, but migrants may fly well above this range. Miller (1957) reported on a sparrow (*Zonotrichia*) migrating at 10,000 feet. (2) The unaided ear does not provide precise directional coverage of a measurable area of sky. (3) Variability in human hearing tends to invalidate comparative quantitative studies by different observers.

When these problems are solved it becomes possible to calculate the number of calls of migrants per unit of area of sky (flight-call density). The relationship of this quantity to true density of migrants is an unknown, but the solution of this larger problem depends first upon the perfection of the audio technique and then upon correlation of audio and visual methods. If the ratio of flight calls to observed birds is found to follow a definite pattern, then the audio technique will be useful for quantitative studies. In any case, the two methods complement each other, the visual method providing more precise quantitative data, the audio method qualitative.

We became interested in these problems while making observations on nocturnal migration in the spring, 1957. Using standard equipment which has found application in a variety of fields, we experimented and developed a promising method for detecting and recording migration.

It is the primary purpose of this paper to present detailed information on the technique and its development, and on the results of our tests with the equipment.

The technique was used to record migration in central Illinois in the fall of 1957, and in the spring and fall of 1958. Data from this nearly continuous record will be presented in another paper, but in order to show the potentialities of the audio method, we have included in the present paper graphs on five nights of migration, representing three seasons, along with a brief discussion of the data.

Acknowledgments

A number of people helped us in the development of the technique and in the pursuit of our studies on migration. We especially wish to express our appreciation to Frank Bellrose and other members of the staff of the Illinois Natural History Survey for encouragement and advice. Glenn Poor contributed substantially in the construction and maintenance of equipment, and particularly with the development of the timing device for the recorder. Jack Ellis and Ronald Labisky helped with the establishment of two of our study stations.

William G. Albright and George W. Swenson of the University of Illinois Electrical Engineering Department gave us valuable advice on the use of electrical equipment and loaned us equipment for making tests. Members of the staff of the University Antenna Research Laboratory kindly loaned us two large parabolic reflectors which were essential to the work. The University Physics Department also loaned us equipment for testing. Glenn E. Stout and other members of the Meteorology Section of the Illinois State Water Survey provided us with weather data. Tom N. Morgan and Jean W. Graber helped us with a number of engineering and ornithological problems.

Barney McMullin of Seymour, Illinois, kindly permitted us to establish an audio station on his property and donated electric power and shelter for our equipment.

Equipment and Method

Heretofore, workers studying migration with the audio method have depended on the unaided ear to detect the calls of migrating birds. Our method employs equipment (Fig. 1) which is basically the same as that used by several workers to record songs of birds. Radio broadcasters have also used parabolic reflectors or horns with their microphones for many years in order to pick up distant sounds. Thus, our only problem was to test and adapt already existing techniques to the particular problems of flight-call detection of nocturnal migrants. As one of our aims is to provide a relatively inexpensive, duplicable system employing readily available parts and equipment, we have made no attempt to approach the ultimate in detection equipment.

The essential items of equipment are: a sound gathering device (parabolic reflector or horn), a microphone, an amplifier, and a recorder. The parabolic reflector gathers sound over a large area (the aperture area of the parabola) and reflects it to a point (the focus) where a microphone or

speaker is located. The microphone converts the variations in air pressure (sound) into variations in voltage at its terminals. These voltage variations are in turn amplified by the audio amplifiers and finally fed to the recording head of a recorder and recorded on tape.

FIG. 1. Equipment used for flight-call detection of nocturnal migrants. From left: recorder, recorder timer, high-pass filter; parabolic reflector surrounded by straw sound baffle, and pre-amplifier with speaker (black box).

Because sound intensity varies inversely as the square of the distance, whereas the amount of sound picked up by a parabolic reflector varies directly as the square of the reflector's diameter, it is a rule of thumb that the maximum distance of detection will vary directly as the diameter of the parabola. Actually, doubling the diameter of a parabola may more than double the maximum distance of sound detection because the additional directivity obtained from the larger parabola will reduce the level of external interfering noise. Maximum range depends on four factors, three of which are in the category of equipment. These are: (1) the size of the parabola, (2) the sensitivity of the microphone, and (3) the sensitivity of the amplifier. The fourth factor, external noise, will in most cases be the limiting factor.

We used a large parabolic reflector (diameter, 72½ inches; maximum depth, 14¼ inches; and focal point, 19 inches), but a logarithmic-base horn might work as well and would probably be less expensive than the reflector.

To pick up sound gathered by the parabola we first tried several crystal microphones, all of which were satisfactory though with some variation in performance. Because crystal microphones deteriorate when exposed to the heat of the sun or to high humidity, we tried an inexpensive 4-inch permanent magnet (pm) speaker with a voice-coil-to-grid matching transformer. The speaker proved to be at least equal in performance to the crystal microphones, and with a thin coating of plastic spray over the cone it has withstood the weather through two seasons of operation.

Most tape recorders have a self-contained amplifier, but for this technique a pre-amplifier which provides additional amplification and a lower noise (internal hiss) level is essential. Many of the high fidelity pre-amplifiers on the market would be satisfactory with very little adaptation, but we obtained excellent results with a relatively inexpensive, simple amplifier which we made for this application. (See Fig. 2 for details of the electrical system.)

The speaker and amplifier were housed in a small metal box (4 × 5 × 6 inches), and the box was made weatherproof with gasket material, gasket seal, and copious quantities of paint.

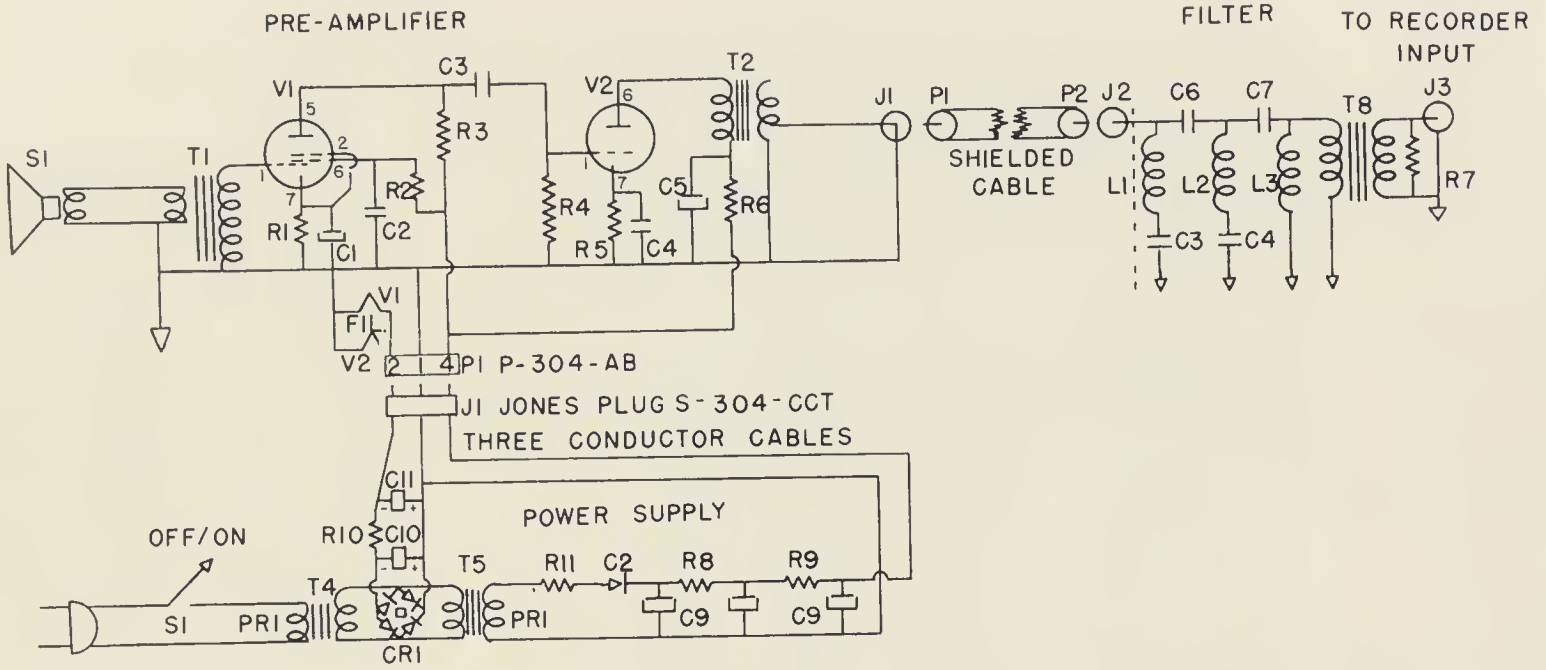
The amplifier box was clamped on a half-inch steel rod extending from the center of the parabola so that the open speaker end of the box was located at the parabola's focal point.

Sockets were provided on the amplifier box for power plug and output connection. Power for the pre-amplifier may be from batteries or from a power supply operating on 110 volts a.c. Initially, we used a 6-volt storage battery and a 90-volt dry cell to power the amplifier. Drain from the dry cell is so small (1.5 ma) that it will last almost shelf life, but the storage battery must be recharged after each 30–40 hours of operation. Our station now uses a power supply operating on 110 volts a.c. (See Fig. 2 for details.)

The output of the pre-amplifier may be fed directly into a pair of headphones to establish a listening post to study the sounds of nocturnal migration. If battery-powered, the equipment is portable, and, with a parabola mounted on truck or car, an investigator can check on migration at widely scattered locations during a single night.

With a fixed station, the output of the pre-amplifier can be carried over a considerable distance through shielded cable to a tape recorder located well away from the reflector in some permanent shelter.

In attempting to record sounds of migration we encountered numerous interfering sounds, many of which were of frequencies below 350 cycles per second. The inclusion of an appropriate high-pass filter (see Fig. 2) between the output of the pre-amplifier and the input of the recorder greatly attenuated frequencies below 350 cycles and improved considerably the range of the equipment without affecting reception of most bird calls.



S1- 4" pm speaker 3.2~ v.c. P-950-4 OXFORD
R1-10K 1W.
R2-39 meg. aerovox CP-1/2 corbonfilm
R3-.5 meg. aerovox CP-1/2
R4-1 meg. aerovox CP-1/2
R5-2500~ 1W.
R6-20K 1W.
C1-25 mF 25V. electrolytic
C2-.1 mF 600V.
C3-.001 mF 600 V.
C4-.25 mF 400V.
C5-16 mF 450 V. electrolytic
V1-6AV.5
V2-6C4

T1-Merit A-2923
T2-Thordorson 22S59
J2-female jack

T4,T5-Thordarson 26F67
PRI 117 vac sec 126V 2A
C9 - triple section 40/40/40 yf, 150 V.D.C. wkg. electrolytic.
R8,R9 - 20K 1W.
C10,C11- Cornell Dubilier 10001 1000 yf, 15 V.D.C. wkg.
R10-10~ 2W.
CR1- Sorkes Tarzian D-17 selenium full wave bridgerectifier

CR2- Federol 1389 65 m.a. selenium rectifier
S1 - toggle switch spst
R11- 50~ , 1W.

R7 - 120 K 1/2 W.
T3 - Thordorson 20A34 transformer 500~/100 K
L1,L2-Thordarson T-20C58 choke 0.75 hy
L3 - J.W. Miller 6324 60-130 mhy, adjustable
C6,C7,C8,C4 - .5 mF 400V.

FIG. 2. Diagram of electrical equipment, pre-amplifier, filter, and power supply, used in audio technique.

Without a tape recorder, the investigator must be in constant attendance while data are being recorded. The addition of a tape recorder to the system permits the recording of migration without a full-time operator and provides a record which can be read and reread at the investigator's convenience. Furthermore, if more than one set of apparatus is available it becomes possible to make simultaneous "observations" at two or more localities.

In our work we used a standard model tape recorder (Revere T 10) with 7½-inch reels. Most standard recorders have recording speeds of 7½ inches and 3¾ inches per second. Even at the slower speed 2400 feet of tape will last less than two hours.

To obtain a nightly 8-hour record of migration during the fall of 1957, we altered the gear ratio of our recorder so that it ran tape at the rate of about two inches per second, and used specially made 14-inch aluminum reels that would carry over 6000 feet of 1½ mil audiotape. With the combination of slow recorder speed and large quantity of tape we could record continuously for over eight hours. To carry these large reels we had bicycle axles mounted on each side of the recorder at the level of the turntable. Several problems were involved in handling this amount of tape. Slowing the recorder speed reduced the fidelity of the recording, especially of high frequency sounds. Such heavy reels tended to burden the recorder and occasionally caused the machine to fail. The greatest drawback in the system was the vast amount of time required to collect the data. Each 8-hour record on tape required eight hours or more to audit. Timing the nightly migration involved correlating the start of recording time with the start of auditing time. Reading the tape was especially tedious for periods when there was little migration.

To remedy these problems we altered our equipment by inserting an automatic, intermittent timer in the circuit of the recorder. Glenn Poor of the Illinois Natural History Survey adapted an ordinary, furnace, stoker-hold, fire timer to open and close only the circuit of the reel-turning motor of our recorder. In operation the amplifier circuit of the recorder remains activated continuously. The timer may be wired to the recorder or arranged with a plug-in. It can be adjusted to obtain any length of recording sample at intervals as short as a few minutes or as long as an hour. Our device is set to take samples of 1½ minutes duration at 10-minute intervals. A maximum total sample of about 2–2½ hours may be recorded on a standard 7½-inch reel at a recording speed of 3¾ inches per second. For a larger sample, the investigator must either slow the recorder or make special reels to handle more tape.

When the timer initiates the recorder motor, a characteristic sound is recorded on the tape. Because these sounds come at regularly spaced, precisely timed, intervals, they facilitate the timing of migration during the night.

Interfering Sounds and Equipment Location

In using a high-gain amplifier system to study migration, the proper location of the equipment is very important. As the relatively weak signal of a bird call is amplified, so also are the sounds from outside sources—trains, highways, wind, livestock, etc.

There is no substitute for a good, quiet location, but filters in the electrical system (see above) can eliminate some of these extraneous sounds. If the investigator is interested in only one or a few species, filters could be used to eliminate virtually all sounds but those in the frequency range of the species being studied.

It is difficult to obtain good recordings of migration in an urban situation, though we did have some success with our equipment placed on top of the Natural Resources Building on the University of Illinois campus. For best results the equipment should be stationed in the country at least two miles from a railroad or major highway. We have found farmers to be most cooperative in permitting us to set up stations on their land. The cost of the electricity used by our equipment is almost negligible.

In any location, sound baffling around the parabola is essential. We used straw bales stacked three-high around the reflector, and found this to be an effective, durable baffle for a permanent station.

Some interfering sounds inevitably get through, or over, the baffle. Most of these are recognizable, but an occasional noise may cause confusion when the tape is read. Nonmigrating birds are a minor nuisance during the night. Many of our tapes have recorded owl calls, and a few have recorded songs of passerines. Relatively few migrants sing full songs in flight, though we have records for some species. It is usually possible to determine from the tape whether a singing bird is moving or stationary. In contrast to the lunar observation method, the present method can be used under a broad variety of weather conditions. Heavy winds (15–20 mph) interfere somewhat, and even moderate rains interfere completely because of the noise of raindrops striking the metal reflector. We have heard migrants during light rains, though the range of coverage is greatly reduced under these conditions. During the fall of 1957, not one of our nightly records was completely lost because of interfering sounds.

Range and Performance of the Equipment

We could not determine the vertical range (above the earth's surface) of our equipment, though we did obtain an accurate estimate of its range with tests conducted on a horizontal plane.

For the tests, we chose a site which offered an uninterrupted view (except for scattered trees and farm houses) of three miles. The area was flat except

for a slight rise at one edge on which we located the reflector. We placed the parabola on edge and baffled it with straw bales at the back and sides. Tests were made on three nights offering a variety of wind conditions.

To check on range and sensitivity of our apparatus we used as a sound source a mechanical noisemaker which emitted a frequency of 2500 cycles per second and which could be heard by the unaided ear at a distance of 1512 feet. By comparison, the call notes of individual House Sparrows (*Passer domesticus*) were audible by the unaided ear to a distance of approximately 1240 feet. In loudness, then, our noisemaker is more nearly comparable to the call notes of *Hylocichla* thrushes as calculated by Ball (1952:49).

In our tests, one person moved straight out from the face of the parabola, signalling at irregular intervals with the noisemaker only. A second person, the auditor, remained at the recorder listening for the signal. From his position at the recorder the auditor acknowledged reception of the sound by signalling with a flashlight. From the distribution of positive tests we plotted the range of the equipment.

Under favorable conditions, with no surface winds, the maximum range of clear detection of the sound signal was 11,400 feet or approximately 2.2 miles. Most flights of nocturnal migrants probably occur well below this height (Lowery, 1951:389).

Heavy winds reduced the range considerably. Tests made on a night when cross winds were 15 to 18 mph indicated a maximum range of 3500 feet.

The true vertical range of our equipment may be greater than the tests indicate. With the parabola in its normal position of vertical coverage, background noises would undoubtedly be less with the same wind conditions than they were in our tests, because wind noise results principally from the action of wind upon objects on the earth's surface. With the baffle that we used, the limits of coverage were sharply defined though, obviously, maximum sensitivity is obtained when the signal is emitted directly over the parabola.

The directional pattern of a parabolic reflector may be computed approximately by formulas (Williams, 1950:147–157). The theoretical pattern of our reflector for a frequency of 2500 cycles is shown in Fig. 3. On paper, the pattern can be represented in two dimensions only, although it is actually three-dimensional, having a shape somewhat like a cigar. The angle of coverage is approximately five degrees with a maximum width of 900–920 feet, at a distance of 8000 feet from the parabola.

Obviously, a broader space is covered, at the higher levels (6000–10,000 feet), and an individual bird would be in range of the parabola longer at these levels. Quantitatively, the significant figure is the number of birds crossing a given line on the earth's surface.

The directional pattern of a parabola varies with the vibration frequency

and intensity of the signal. Thus, loud calls of waterfowl would be detectable well beyond the range given for our tests, and, in calculating "flight-call density," these factors must be considered. The frequency range of the equipment (with filter) is from 350–5000 cycles per second using a recorder speed of 3¾ inches per second.

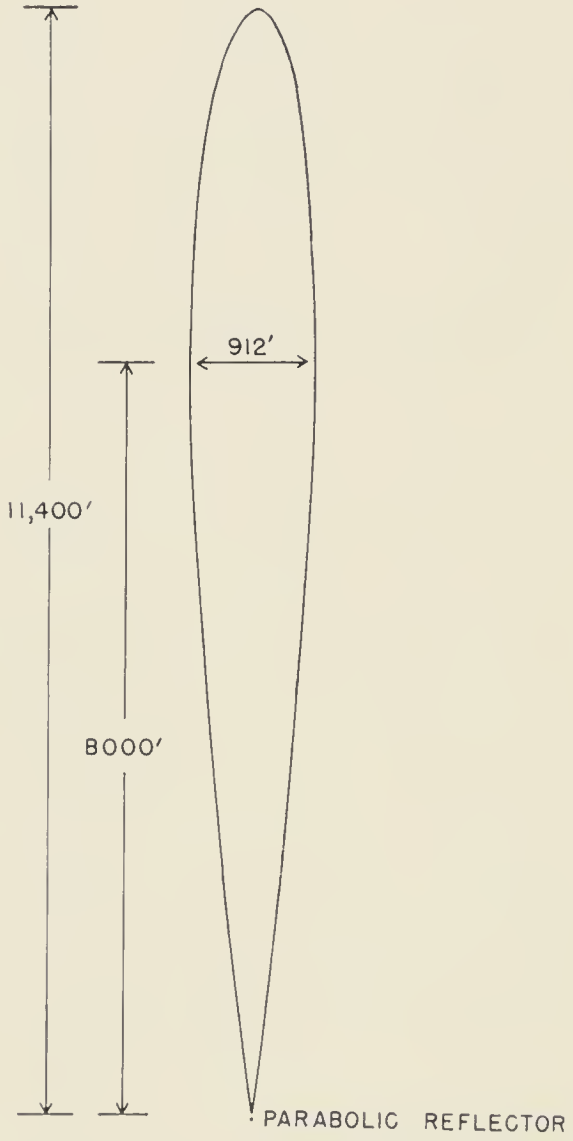


Fig. 3. Theoretical directional pattern of a 72-inch diameter parabolic reflector for a frequency of 2500 cycles per second or wavelength of 5.3 inches. The maximum range of detection of calls comparable in frequency and loudness to those of the *Hylocichla* thrushes is 11,400 feet. The maximum diameter covered is 912 feet at a distance of 8000 feet from the parabola.

Collection of Data and Sample Results

We have found the equipment described above to be very helpful in studies on nocturnal migration in the prairie region of east-central Illinois. With a semipermanent station, a nightly record of migration can be obtained with an expenditure of two to four hours per day, depending upon the location of the station and the length of the recording sample. The tape-recording must be started each evening, and the tapes retrieved and audited on the following day.

In transcribing data from the tapes we have phoneticized all call notes and, whenever possible, identified individual call notes. The time of calling was also noted in each case. From these basic data the accompanying graphs (Figs. 4–8) were constructed.

Though the audio technique in its present form is intended to complement direct visual studies, it can provide information on certain aspects of migration even without visual study.

The following discussions are based on the graphs and consider four general problems in which audio records may be helpful: (1) the hours of nocturnal migration and of calling by nocturnal migrants, (2) flight-call density, (3) the kinds of calls of nocturnal migrants, and (4) the conditions under which migration occurs.

Hours of Nocturnal Migration and Calling of Migrants

Data from visual and audio studies have been contradictory as to the hours of the night when migration occurs. From lunar observations at many localities, Lowery (1951:415–416) determined that maximum densities of migrants occurred before 1 a.m., with peak numbers coming between 10 p.m. and 1 a.m. Using an audio method in Gaspé, Ball (1952:55) found that there were two peaks during the night, one before 10 p.m. and a second between 3:30 a.m. and dawn.

Our recordings (for 125 nights) show only one *consistent* pattern. In central Illinois, migration may be detected at any hour during the night from sundown to sunup, but if migration continues until dawn there is often a marked increase in calling by migrants in the predawn hours. This peak depends at least upon the species of migrants involved and the factors which affect the intensity of dawn light. Increased calling at this time is particularly characteristic of the *Hylocichla* thrushes, but probably also occurs in other species. The predawn peak in calling does not necessarily indicate that more birds are flying at that time. The peak may reflect an increased incidence of calling only, and not an actual increase in flight density. Our observations on a captive flock of six Swainson's Thrushes (*Hylocichla ustulata*), five Gray-cheeked Thrushes (*H. minima*), and one Veery (*H. fuscescens*) for a week in

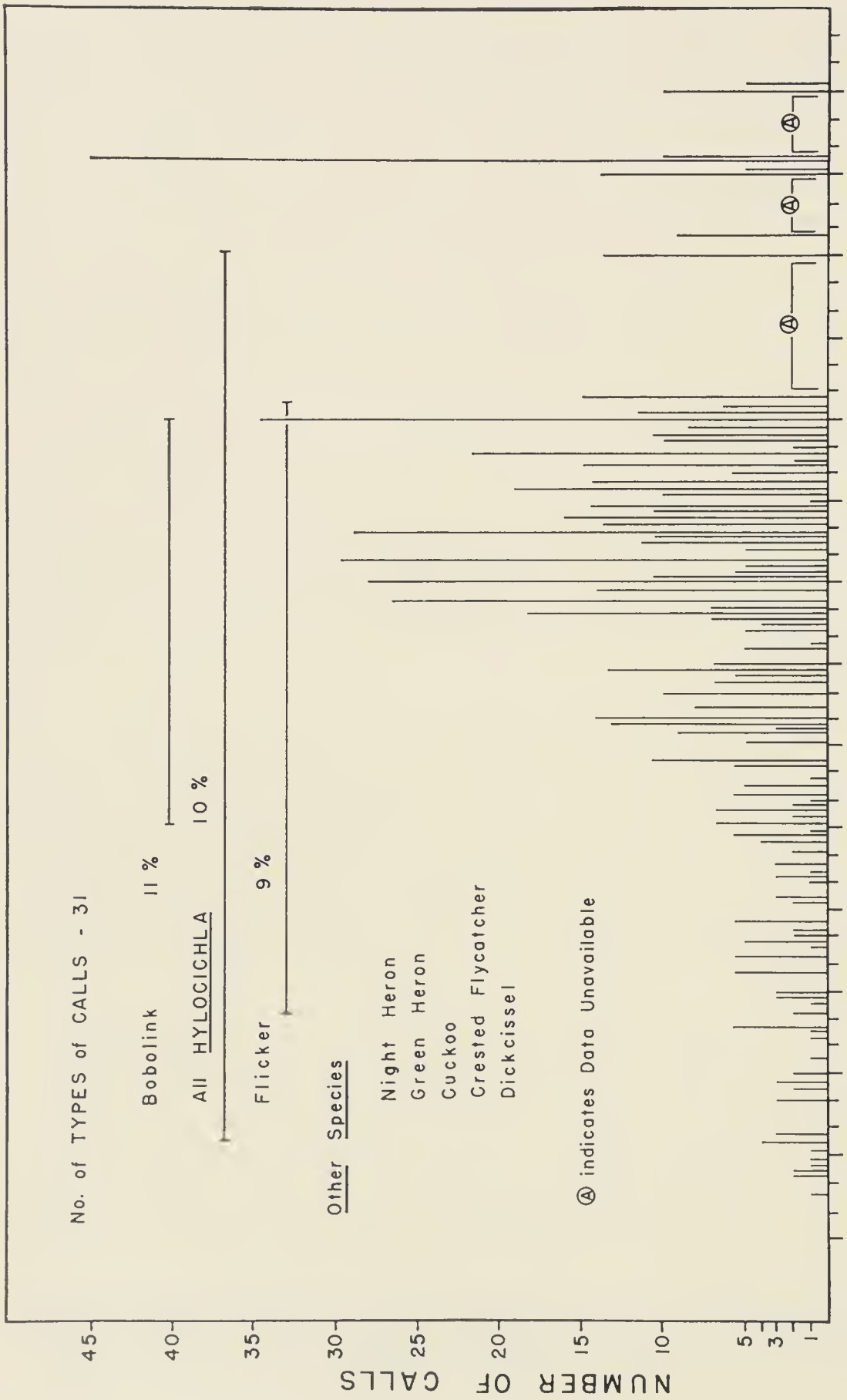
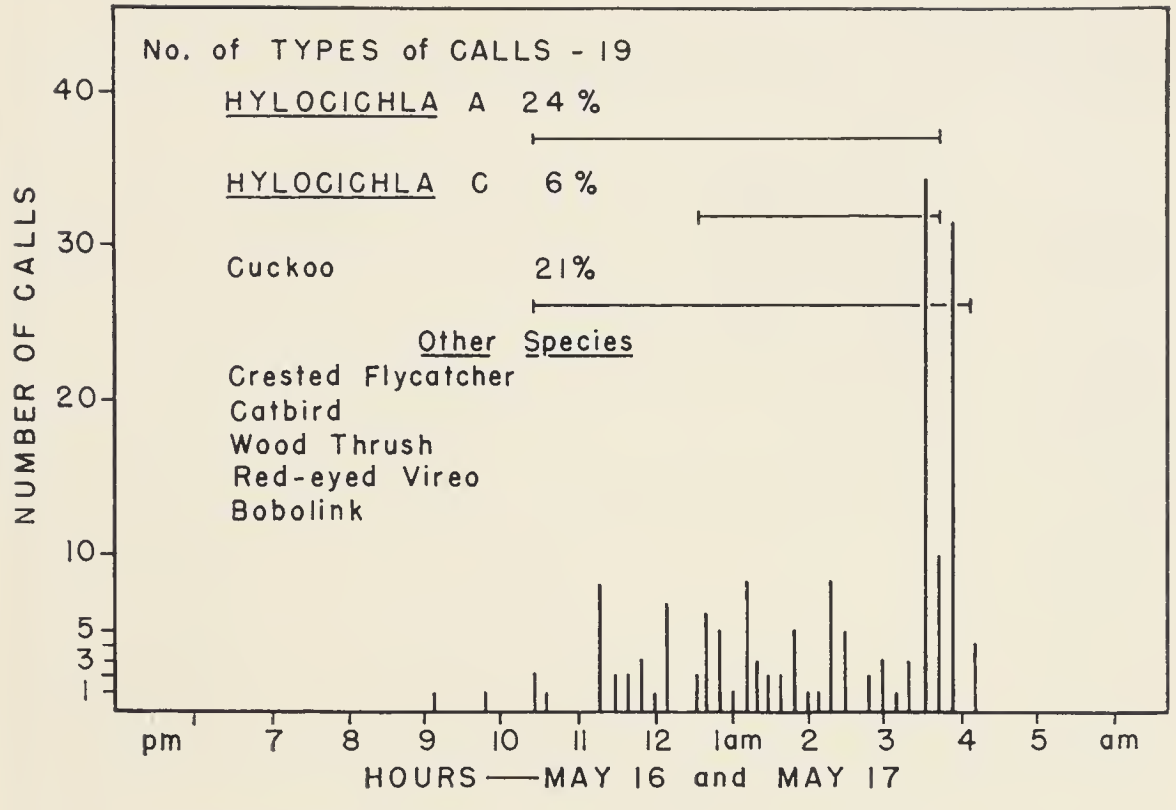
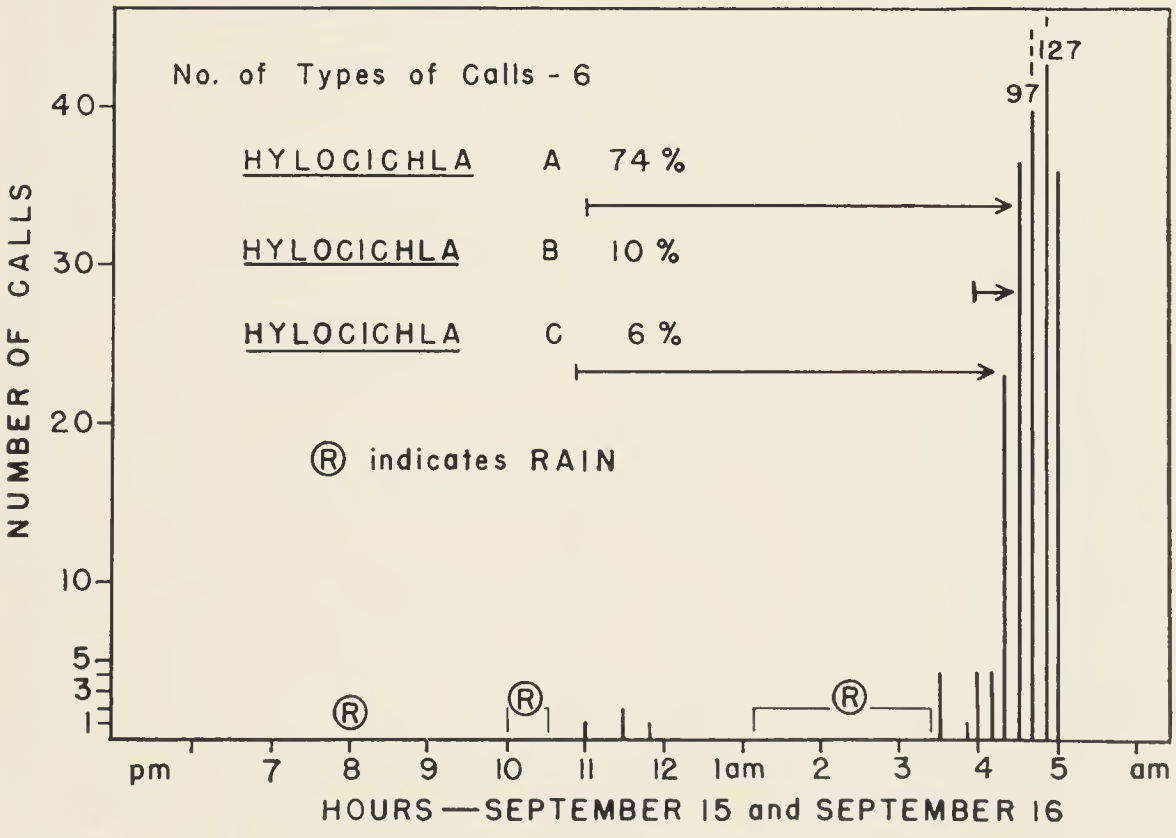
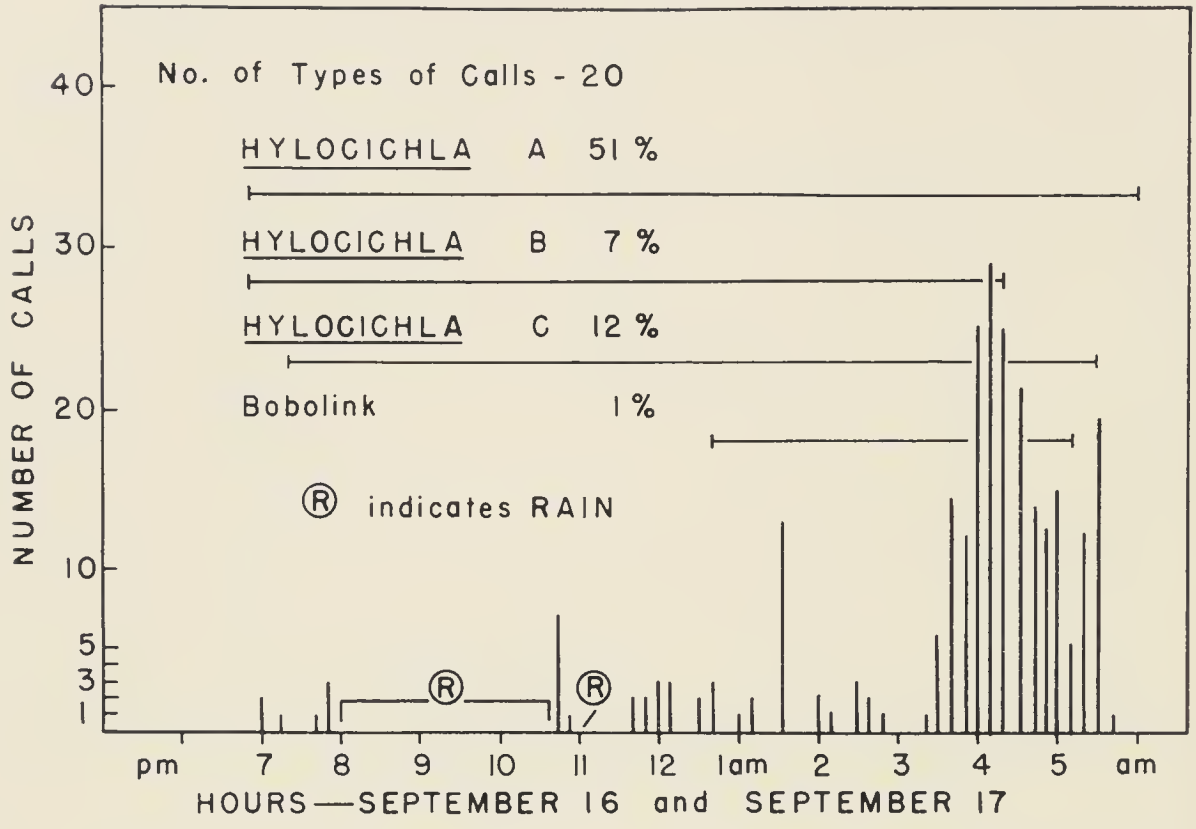


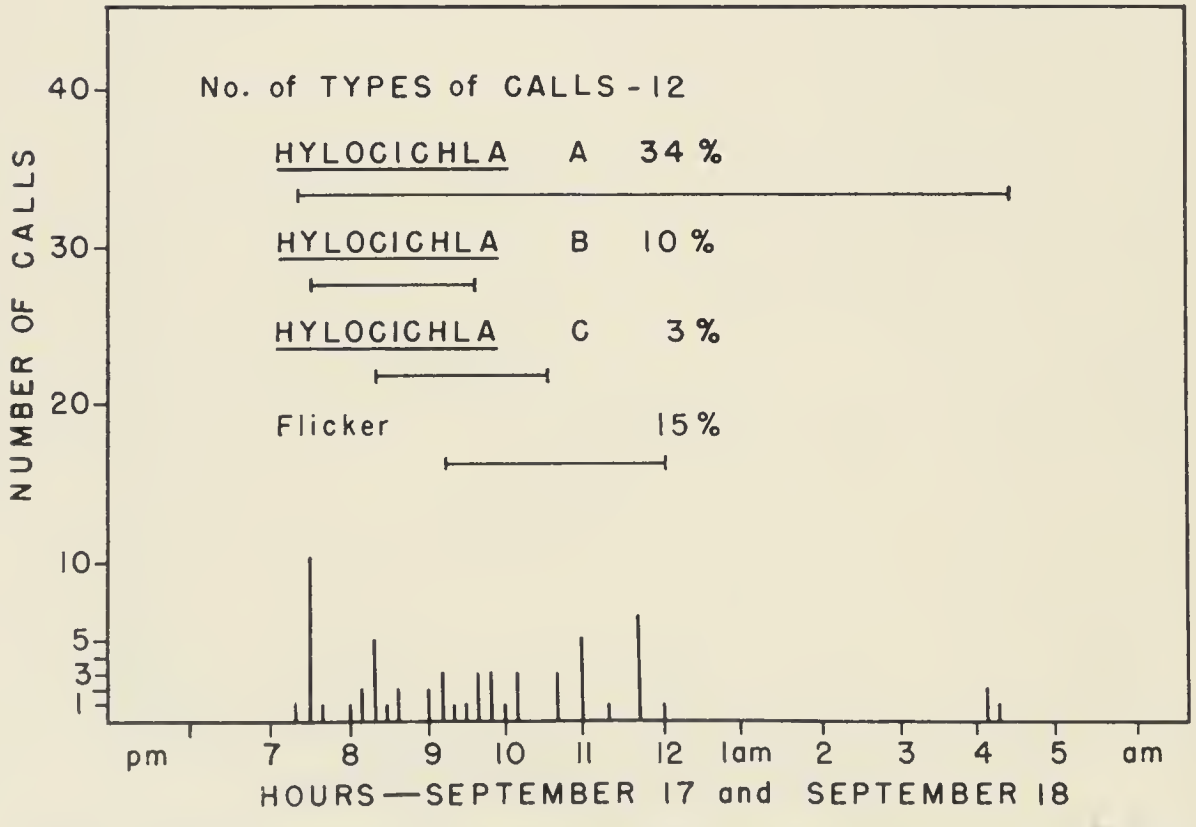
FIG. 4. Record of calls of nocturnal migrants transcribed from a continuous tape recording made on the night of September 12–13, 1957. Gaps marked "A" represent periods of power failure. Percentage figures represent per cent of total calls.





FIGS. 5 (above) and 6 (below). Records of calls of nocturnal migrants passing through a circular area with a maximum diameter of 912 feet on nights in 1958, near Champaign, Illinois. Histograms show number of calls recorded in 1½-minute periods every 10 minutes during the nights. Percentage figures represent per cent of total calls.





FIGS. 7 (above) and 8 (below). Records of calls of nocturnal migrants passing through a circular area with a maximum diameter of 912 feet on nights in 1958, near Champaign, Illinois. Histograms show number of calls recorded in 1½-minute periods every 10 minutes during the nights. Percentage figures represent per cent of total calls.

mid-September, 1958; and on two captive Gray-cheeks for three weeks in October corroborate the view that although these birds may call at almost any hour of the night, they actually call with greatest frequency in the predawn period.

It seems reasonable to assume that if some species, say Swainson's Thrush, is heard calling throughout the night the number flying may be just as great early in the night as late, but that a higher proportion of these thrushes call just before dawn than during the rest of the night.

Figs. 6–8, which show one complete migratory wave in the fall of 1958, help explain that any number of nightly patterns of migration may exist. Our recording station showed no evidence of nocturnal migration after 1 a.m. on September 15, but at 10:50 p.m. on September 15, the first loud calls (probably Gray-cheeked Thrushes) were recorded for a migration that was to continue throughout the night hours until the early morning of September 18 (Figs. 7 and 8). On the following night (September 19) there was little migration, and none of thrushes.

These records show that at least certain species of nocturnal migrants fly throughout the night as long as conditions prevail which favor migration.

Assuming a take-off time of 6:30 p.m. (September 15) and a flight speed of 35 mph, the first migrants of this wave probably started about 150 miles north of Champaign. If the front edge of this wave continued to move through the night hours as long as birds passed the Champaign station, the migration would have carried an individual bird about 900 miles by the morning of September 18, when the last birds passed Champaign.

The nightly migration patterns, then, at any given station depend upon the extent of the mass movement, the relative positions of the leading and trailing edges of the migrating mass of birds, and the geographic extent of the conditions which favor or retard migration.

Our data do not completely explain the discrepancy in nightly patterns of migration as determined by auditing with the unaided ear (Ball, 1952:55), and by lunar observations (Lowery, 1951:418). Both Lowery (1951:419) and Ball (1952:57) considered the possibility that migrants may fly higher (thus out of hearing) during the middle hours of the night than during the early and late hours of darkness. Both authors dismissed the possibility as improbable, but our data suggest that such an arc flight may be a reasonable explanation.

Flight Call Density

Fig. 4 shows the distribution and number of calls of nocturnal migrants during a heavy migration on the night of September 12–13, 1957. This record, in contrast to those shown in Figs. 5–8, is based on a continuous 7-hour tape

recording, and the distribution of calls suggests that migrants were flocked, not evenly distributed in the sky. Ball's (1952:57) data also suggest an uneven (flocked) distribution of migrants. However, Lowery (1951:410) and Lowery and Newman (1955:246) present overwhelming evidence that nocturnal migrants are relatively evenly distributed in flight. It is entirely possible that it is only the calls, not the migrants, which have a "clumped" distribution. In fact, during the predawn peak in calling when the highest proportion of migrants are calling, the distribution of calls is not "clumped," but uniform and continuous.

In calculating flight-call density we have used the figures for the predawn peak as an index because they probably most nearly represent the true numbers of birds in flight.

Figs. 5 and 6 show peak numbers of calls per 1½ minutes for the heaviest migrations recorded in the spring (34) and fall (127) of 1958. These calls were emitted in an area with a maximum diameter of 912 feet. Lowery (1951: 434–436) gives spring flight-densities (number of birds crossing any part of a circle one mile in diameter per unit of time) for several localities. A maximum nightly density for Ottumwa, Iowa, in May was 54,600 birds. By comparison, the flight-call density for Champaign in spring (May 16–17) was 78,800 calls per 10 hours and in fall (September 15–16), 294,000 calls.

With regard to these calculations, the question arises as to whether an individual bird calls more than once as it flies through the area covered by the parabola. There is variation in frequency of calling between species and even by individual birds. Ball (1952:54) stated that a single Hermit Thrush (*Hylocichla guttata*) called at intervals of 12–13 seconds on a straight course, while in a curving flight down a hill slope it called at intervals of 6–9 seconds. Our observations in the vicinity of the Champaign audio station during many night and dawn periods of the past two years indicate that in the majority of cases each recorded call note represented a different bird. In straight flight at an average speed of 35 mph a given bird would be in range of the parabola for a maximum possible period of 18 seconds. Again our observations on captive thrushes are pertinent. In this flock, even in the predawn period, individual birds called only at intervals of several (2–45) minutes during nights in September and October.

Identification of Call Notes

The identification of species of birds from their nocturnal calls uttered in migration is a field of study in itself, and one which deserves more attention.

Some call notes may be learned through observations of migrants at dawn. Some birds may still be flying at this time, while others have alighted. An

even better method is to listen to captive birds during periods when they exhibit *zugunruhe*.

We have been able to identify only a low percentage of the total number of calls on our tapes, and even so our identifications must be considered tentative. In Figs. 4–8 we have used letter designations for the thrushes rather than species names. "*Hylocichla* A" is probably Swainson's Thrush. The letter actually designates two types of calls which we have phoneticized as *whit* and *wheek*. We have heard Olive-backed Thrushes utter both these calls. "*Hylocichla* B" represents a call note which we phoneticized as *pee-oort*, while "C" represents the note *peer*. The latter two we have heard from Gray-cheeked Thrushes, but there is a possibility that the Veery may utter similar cries in migration.

Weather Conditions which Accompany Migration

Potentially, one of the most valuable types of data to be gained from audio studies is information on the conditions under which migration occurs.

For example, the mass migration of September 15–18, 1958 (Figs. 6–8), occurred largely with conditions of complete cloud cover and intermittent rains. At Champaign there was continuous 10/10 cloud cover from 7 a.m. September 15 until 7 p.m. September 17. At least part of this time the clouds were in three layers: 8/10 low stratus (top level at 1300–1500 feet), 3/10 strato-cumulo (base at 7000–8000 feet), and 10/10 probable ice clouds (base at 15,000–20,000 feet). Daily weather maps issued by the U. S. Department of Commerce for these dates show that the 10/10 overcast was extremely widespread, covering most of the states of Illinois, Wisconsin, Indiana, Iowa, and Missouri.

In the evening of September 16, birds began migrating at least by 6:35 p.m., not having seen direct sunlight all day at Champaign. Migration continued throughout the night with the possible exception of the periods of intermittent rain (see Fig. 4), at which times the audio technique was useless. It is possible that migrants actually flew through the rains because migrants were recorded immediately before and immediately after the precipitation. It is also possible that the birds were flying above the rain, but they had to be flying below the 15,000-foot ceiling or they would not have been detected by the audio equipment.

Under the conditions mentioned it does not seem likely that migrants were using celestial orientation as described by Sauer (1958:44).

Literature Cited

Ball, S. C.

1952 Fall bird migration on the Gaspé Peninsula. *Peabody Mus. Nat. Hist. Yale Univ. Bull.*, 7:1–211.

Carpenter, F. W.
1906 An astronomical determination of the heights of birds during nocturnal migration. *Auk*, 23:210–217.
Howell, J. C., A. R. Laskey, and J. T. Tanner
1954 Bird mortality at airport ceilometers. *Wilson Bull.*, 66:207–215.
Kopman, H. H.
1904 Bird migration phenomena in the extreme lower Mississippi Valley. *Auk*, 21:45–50.
Libby, O. G.
1899 The nocturnal flight of migrating birds. *Auk*, 16:140–146.
Lowery, G. H., Jr.
1951 A quantitative study of the nocturnal migration of birds. *Univ. Kans. Publ. Mus. Nat. Hist.*, 3:361–472.
Lowery, G. H., Jr., and R. J. Newman
1955 Direct studies of nocturnal bird migration. *In* Recent studies in avian biology. Univ. Ill. Press, Urbana. pp. 238–263.
Miller, A. H.
1957 Migratory flight of a *Zonotrichia* at 10,000 feet above ground level. *Condor*, 59:209–210.
Sauer, E. G. F.
1958 Celestial navigation by birds. *Sci. Amer.*, 199:42–47.
Scott, W. E. D.
1881 Some observations on the migration of birds. *Bull. Nutt. Orn. Club*, 6:97–100.
Sutter, E.
1957*a* Radar Beobachtungen uber den Verlauf des Nachtlichen Vogelzuges. *Revue Suisse de Zoologie*, 64:294–303.
1957*b* Radar als Helfsmittel der Vogelzugforschung. *Der Orn. Beobachter*, 54:70–96.
Tyler, W. N.
1916 The call-notes of some nocturnal migrating birds. *Auk*, 33:132–141.
Williams, P. H.
1950 Antenna theory and design, 2. Sir Isaac Pitman and Sons, Ltd., London.

STATE NATURAL HISTORY SURVEY DIVISION, URBANA, ILLINOIS; AND WCIA TRANSMITTER, SEYMOUR, ILLINOIS, FEBRUARY 16, 1959

CALCULATION OF FLIGHT DIRECTIONS OF BIRDS OBSERVED CROSSING THE FACE OF THE MOON

BY I. C. T. NISBET

THE classic paper of Lowery (1951) on the study of nocturnal migration by observing birds passing in front of the moon has established this technique as an important part of the field study of migration. Most migration students are unable to use it, however, because of the mathematical calculations necessary to reduce the observational data. The purpose of this paper is to provide instructions by which any observer, armed only with a telescope, a compass and a protractor, may perform these calculations without technical assistance.

The observational method and the theory of the calculation are described by Lowery at considerable length, and reference should be made to his paper for more details than can be given here (see also Appendix). The chief difficulties arise from the oblique angle at which the birds are viewed, which distorts the direction in which they are actually flying. This effect becomes more serious as the moon becomes low in the sky, and when it is close to the horizon the birds' flight directions cannot be determined at all. Even if observations are avoided in these circumstances, a mathematical treatment is usually necessary before directions of flight can be determined with any accuracy.

Lowery avoided this difficulty in part by processing the data from all his collaborators himself, but this procedure was so time-consuming that he was forced to adopt a method of approximation, grouping the data before making the calculation. However, Tunmore (1956) has recently pointed out that Lowery's approximation might lead to large errors if it should be used when the moon is low in the sky. A method of grouping will be described here which introduces errors no larger than those inherent in the observational method itself.

Observations

Position of the Moon.—To reduce the data it is necessary to know the compass direction and altitude (angle of elevation) of the moon at the time that each bird is seen. As Lowery explains, this information can be obtained from published tables, but these tables are not generally available and it is much simpler to measure the angles directly.

The compass direction should be measured in degrees (North, 0° or 360°; East, 90°; South, 180°; West, 270°; etc.). A correction is added or subtracted for the difference between true north and magnetic north (in the United States, for example, the local correction is given on the topographic maps published by the U. S. Geodetic Survey), and the result is the azimuth angle Z.

The altitude is measured by attaching a protractor, with a plumbline (thread and small weight) hanging *freely* from its *exact* center, to the side of the telescope so that the base of the protractor is exactly parallel to the line of sight (see Fig. 1). When the moon is in the center of the telescope field the position of the thread on the protractor scale is read and the reading subtracted from 90°; this gives the altitude A in degrees.

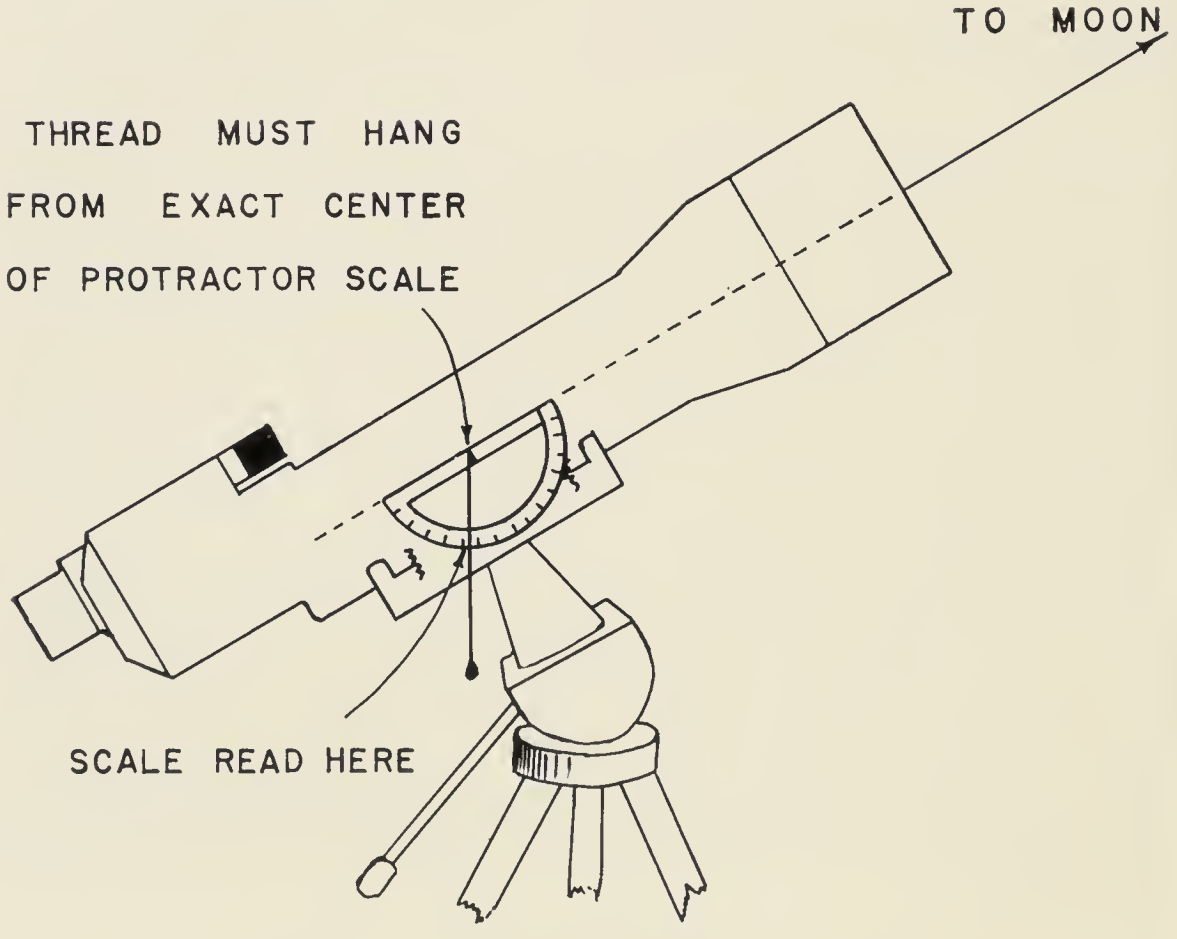


Fig. 1. Attachment of protractor to telescope.

Each of these measurements should be made at frequent intervals, about once every half hour and at least four times in all during the observation period. At the end of the period each of the angles is plotted against the time of the reading on a piece of graph or squared paper, and smooth curves are drawn through the points, averaging out small errors in measurement. It should then be possible to read off from the curves the exact azimuth and altitude of the moon at any intermediate time, within five degrees for the former, and two degrees for the latter.

If the altitude of the moon is less than 14° the calculation should not be made at all: observations made in these circumstances have only a qualitative value.

Apparent Directions of Flight.—Observations are best made with a low power telescope (15× to 20×) on a rigid tripod mounting; the latter is essential, not only for comfort, but also for the measurement of the altitude which was described above. At least two collaborators are required, one to observe and one to record the data, and positions should be changed frequently to avoid fatigue and eyestrain. The period for which the moon is kept under continuous scrutiny must be recorded exactly, with note of any interruptions, such as those which occur when the observers change positions.

The apparent flight direction of each bird is estimated by visualizing a clock-face on the moon, with 12 o'clock at the top. The "hours" at which the bird appears to enter and leave the moon are noted, to the nearest half-hour unless the bird is flying more or less "vertically" (e.g., from 5 o'clock to 2), when it is sufficient to record to the nearest hour. This information is recorded for each bird, together with the time to the nearest minute and any other relevant information.

(The observational method recommended here is exactly that described by Lowery, and his paper should be consulted for fuller details.)

Calculations

The method of calculating the flight direction of a single bird will be outlined first, and the grouping of the data discussed later.

Flight Direction of a Single Bird.—(1) The "hours" at which the bird entered and left the moon are used to obtain an angle B from Table 1. This is the angle which the bird appears to make with the horizontal, and the remainder of the calculation consists in its correction for the effect of foreshortening.

(2) If B is not 0° or 90°, the moon's altitude A at the time of the observation is determined from the graph, to the nearest 2° if less than 22°, to the nearest 5° if between 25° and 50°, to the nearest 10° if over 50°. From the two angles B and A a new angle C is obtained from Table 2. If B is 0° or 90° there is no correction and C is the same as B.

(3) The moon's azimuth Z at the time of the observation is obtained from the second graph.

(4) It is now necessary to note whether the bird appeared to be flying upwards or downwards, and whether to the left or right (e.g., 8 o'clock to 2 is up and right, 2 to 8 is down and left). Four possibilities arise:

Up and right: add 90° to Z and add C.

Down and right: add 90° to Z and subtract C.

Down and left: subtract 90° from Z and add C.

Up and left: subtract 90° from Z and subtract C.

The result is the true flight direction of the bird in degrees (if negative, 360° is added; if over 360°, 360° is subtracted).

Table 1

Determination of the Angle B, the Apparent Direction of Flight

Hour of entering:	12	1	2	3	4	5	6	7	8	9	10	11
Hour of leaving												
12	X	15	30	45	60	75	90	75	60	45	30	15
1	15	X	45	60	75	90	75	60	45	30	15	0
2	30	45	X	75	90	75	60	45	30	15	0	15
3	45	60	75	X	75	60	45	30	15	0	15	30
4	60	75	90	75	X	45	30	15	0	15	30	45
5	75	90	75	60	45	X	15	0	15	30	45	60
6	90	75	60	45	30	15	X	15	30	45	60	75
7	75	60	45	30	15	0	15	X	45	60	75	90
8	60	45	30	15	0	15	30	45	X	75	90	75
9	45	30	15	0	15	30	45	60	75	X	75	60
10	30	15	0	15	30	45	60	75	90	75	X	45
11	15	0	15	30	45	60	75	90	75	60	45	X

Note: directions corresponding to "half-hours" can be obtained by interpolation.

Accuracy.—The accuracy of the calculated flight direction may be estimated from Table 2. Assuming that A and B are correctly observed to the nearest figure given in Table 2, and that Z is measured correctly to the nearest multiple of 5°, the following estimates are obtained for the maximum possible error introduced by the approximations used in the calculation:

Moon's altitude A:	14°	16°	20°	30°	40°	60°
Max. error in direction:	20°	18°	15°	13°	12°	12°

The probable error of each calculated direction will be roughly one-third of the maximum error given in the above table.

Two other sources of error are not included in the above estimates: the possibility that the bird may not be flying exactly horizontally (which would lead to error in determining B), and errors in observation. Both may become serious as the moon becomes low in the sky—a mistake of "half an hour" in recording the apparent direction of flight, for example, leads to an error in the calculated flight direction which approaches 30° if the altitude of the moon falls below 15°—and the results should always be evaluated with this in mind.

TABLE 2

DETERMINATION OF THE ANGLE *C*

Moon's altitude *A*	Apparent direction of flight *B*						
	7½	15	22½	30	45	60	75
14	29	48	60	67	76	82	86
16	26	44	56	64	75	81	86
18	23	41	53	62	73	80	85
20	21	38	50	59	71	79	85
22	19	36	48	57	69	78	84
25	17	32	44	54	67	76	84
30	15	28	40	49	63	74	82
35	13	25	36	45	60	72	81
40	12	23	33	42	57	70	80
45	11	21	30	39	55	68	79
50	10	19	28	37	53	66	78
60	9	17	26	34	49	63	77
70	8	16	24	32	47	62	76

Note: if the moon's altitude is greater than 70° the birds are almost vertically overhead, and their flight directions should be estimated directly.

Grouping of the Data.—Once the above calculation has been carried out a few times, it should be possible to perform it quickly and accurately. It is then possible to reduce the labor of analysis by judicious grouping of the data.

I have found useful the following method of grouping. The data sheet is ruled into columns, with one column devoted to each step in the calculation, and one line to each bird. Two columns record, for easy reference, the variation of the azimuth Z and altitude A of the moon through the observation period. Then a single calculation suffices for all the birds with the same apparent angle of flight B and the same values of A (within the accuracy demanded by Table 2) and Z (within the nearest five degrees). These criteria usually permit the grouping in 15- or 20-minute periods of all birds flying in the same apparent direction, and the limits of error quoted in the preceding paragraph are not exceeded.

FLIGHT DENSITY

Before the results can be used for quantitative studies of migration, it is necessary to calculate the flight density (e.g., the number of birds crossing a mile front in an hour) from the number of birds seen. However, this calculation requires an assumption to be made concerning the variation of the density with height. Using the scanty data then available, Lowery (1951) assumed for the purposes of calculation that the flight density was uniform with height up to a ceiling of one mile. Recent work by Harper (1958) suggests that this

assumption is reasonably good, in that nocturnal migrants in southern England usually fly at heights between 2000 and 5000 feet, and to give figures comparable with Lowery's the same assumption will be used here. However, variations in the average height of migration (such as those found by Harper) would have a serious effect on the calculated flight densities (see Appendix), and until a method is devised to detect such variations the results cannot be quantitatively accurate. Hence, there is no need to perform the calculation with great accuracy.

For each hour of observation, the numbers of birds seen flying in each direction are grouped under 22½° headings, and a correction is made for any gaps in observation to give an estimate of the total number of birds crossing the moon in each 22½° sector per hour. The altitude of the moon in the middle of the hour is noted, and used to obtain a correcting factor from Table 3: if the birds are flying more or less "horizontally" (e.g., 8 o'clock to 4), factor X is used; if they are flying more or less "vertically" (e.g., 1 o'clock to 5), factor Y is used. Approximate correcting factors for oblique directions can be obtained by interpolation. The number of birds seen per hour is multiplied by the correction factor: this gives an estimate of the number of birds crossing a mile front per hour, in the direction concerned (this quantity is termed the "Sector Density" by Lowery).

Table 3

Correction Factors for Determining Flight Densities

Moon's altitude A:	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	90°
Correction factor X:	15	30	40	60	80	100	120	140	180	210	240
Correction factor Y:	60	80	100	120	140	150	170	180	210	220	240

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Summary

Instructions and tables are given from which observers without mathematical training can calculate flight directions and approximate densities of migrating birds observed flying across the face of the moon. Estimates are given of the accuracy of the results.

The mathematical theory of the calculations is outlined in an Appendix. It is pointed out that the results obtained for the flight density depend critically on the distribution of migrating birds with height, which is not yet known.

Appendix: Mathematical Background

The method described above for computing flight directions is derived from an equation equivalent to Lowery's equation (1), namely,

$$\tan\,(\tfrac{1}{2}\pi + \eta + Z) = \operatorname{cosec} A \tan B,$$

where η is the bird's flight direction, A and Z are the altitude and azimuth of the moon, and B is the apparent direction of the bird's flight across the imaginary clock-face, measured counterclockwise from the line from 9 o'clock to 3. The only assumptions used in deriving this equation are that all the birds are flying horizontally and that the earth is flat.

The density of migration is calculated by assuming a distribution with height h (measured in miles) of $f(h)$ birds per mile front per hour. Thence, assuming that the birds are flying randomly, not in flocks, the correction factors are:

$$X = \frac{120 \sin^2 A \int_0^\infty f(h)\,dh}{\int_0^\infty h\,f(h)\,dh}; \qquad Y = X \operatorname{cosec} A,$$

under the approximation that the moon subtends an angle of 1/120 radians at the surface of the earth. Using Lowery's simplifying assumption that $f(h)$ is constant up to $h = 1$ mile and zero above this, we obtain:

$$X = 240 \sin^2 A; \qquad Y = 240 \sin A,$$

the values given in Table 3. The correction factors do not depend strongly on the *shape* of the assumed distribution: if, for example, we assume $f(h) = h \exp(-2h^2)$, a more realistic distribution which falls to zero at the ground, peaks at $h = \frac{1}{2}$ mile and drops off rapidly above $h = 1$ mile, they are altered by only 25 per cent. However, if two possible distributions have the same shape but differ in scale-height, the number of birds seen will vary directly with the scale. For example, if the total flight density remains unaltered but the ceiling falls from $h = 1$ mile to $h = \frac{1}{2}$ mile, the number of birds actually seen will be halved, and the estimate of flight density will be wrong by a factor of two. As Lowery points out (1951:389–390), hour-to-hour or night-to-night variations in the average height of the migrating birds cause serious errors in the quantitative estimates of flight density.

Literature Cited

Harper, W. G.
1958 Detection of bird migration by centimetric radar—a cause of radar 'angels.' *Proc. Roy. Soc.*, B 149:484–502.

Lowery, G. H., Jr.
1951 A quantitative study of the nocturnal migration of birds. *Univ. Kansas Publ. Mus. Nat. Hist.*, 2:361–472.

Tunmore, B. G.
1956 The visual observation of night migration. *Bird Study*, 3:237–241.

Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, February 28, 1959

SONG AND TREE SPARROW WEIGHT AND FAT BEFORE AND AFTER A NIGHT OF MIGRATION[1]

BY CARL W. HELMS

THERE has been much recent interest in weight and fat increases before and during migration, particularly in sparrows and buntings (Emberizinae). These weight and fat increases, representing reservoirs of stored energy which may be used during migratory flight, have been well documented for the White-throated Sparrow (*Zonotrichia albicollis*) by Odum (1949). However, Nice (1937) found no weight increase in Song Sparrows (*Melospiza melodia*) during migratory periods. Wolfson (1945:117–118) suggested that the presence of resident individuals obscured any weight increase which might have been shown by migrant birds. Nice (1946) reanalyzed her data, but found no weight increase in migrants. Farner (1955) cautions us that physiological adjustments during migration may be different in different species.

Helms and Drury (1959), comparing weight and fat variation in winter and migrant Tree Sparrows (*Spizella arborea*) and Slate-colored Juncos (*Junco hyemalis*) find that such differences between species do exist. Although no statistically reliable weight and fat increases were found to be associated with migration in Tree Sparrows, weight and fat variation become temperature-independent and are therefore subject to some other control, presumably associated with migration. In order to determine whether migratory birds such as Song and Tree Sparrows show any weight and fat increase with migration, and since this increase is not shown by mean data during migratory periods, it is important to gather statistically reliable data before and after a migratory flight is known to have occurred. Comparison of these data with one another and with means from mixed "resident" and "migratory" populations of the species might permit clarification of this problem.

The purpose of this paper is to present weight and fat data collected before and after a migratory flight, and from these data and that of Helms and Drury (1959), tentatively propose two distinct patterns of weight-fat variation in emberizines.

METHODS

Between April 4 and 6, 1958, while "mist-netting" in the "Pine Woods" area on Plum Island, Parker River National Wildlife Refuge, Newburyport, Massachusetts, I caught a number of migrant Song Sparrows. From April 5 to 6, there was a reduction from about 5000 to 2000 Song Sparrows on the island as estimated by roadside counts (the resident population was about 300 birds). The evening of April 5 was partly cloudy with light southwesterly

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winds. Mean temperatures were as follows: April 4, 42°F.; April 5, 48°F.; April 6, 44°F. Although no migratory departure of buntings was seen, about 200 Horned Larks (*Eremophila alpestris*) were observed leaving a marshy area just at dark and flying north. Isolated flight calls were heard during the early part of the night, indicating a general northward movement of several species of early migrants. Individual Song Sparrows were observed feeding and moving north during the day of April 5. On April 6, I caught only four birds which had been banded the previous day (two were residents and two had been weakened by our taking of blood samples). These facts indicate a general migratory movement during the day of April 5, and particularly that night along this part of the Atlantic coast.

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Song Sparrow

Morning weight and fat data for Song Sparrows captured before and after this migratory movement are summarized in Table 1. These data are shown graphically in Fig. 1.

Table 1

Song Sparrow Weight and Fat Before and After a Night of Migration

	Sample Size	Mean Weight	Range	S. D.	S. E.	Fat
Pre-flight Data (April 5, 1958)	61	22.48	18.2–26.4	1.67	0.21	2.35
Post-flight Data (April 6, 1958)	44	21.07	17.4–26.2	1.61	0.24	1.40

Key: Sample Size = number of individual weights (n); Mean Weight = average weight in grams; Range = lowest and highest weights in grams recarded; S. D. = standard deviatian, a statistical measure af spread af weight values an either side af the mean; S. E. = standard errar, a measure af reliability af the sample. For an explanatian af fat values, see text.

The mean weight, as indicated in Table 1, was 1.41 grams lower on the morning of April 6 than before migration on April 5. This difference is statistically significant ($P = <.001$, *i.e.*, there is less than one chance in 1000 that this difference could have occurred by chance). Afternoon weights on April 5 (mean weight in grams = 22.86; S.D. = 1.88; S.E. = 0.50) are excluded, since, due to rain, I have no comparable weights on April 6.

Fat reserves of all birds handled were determined visually as described by Helms and Drury (1959); they were assigned numbers from one to five (our "no fat" class. Class 0. is found only during post-nuptial molt). Birds in

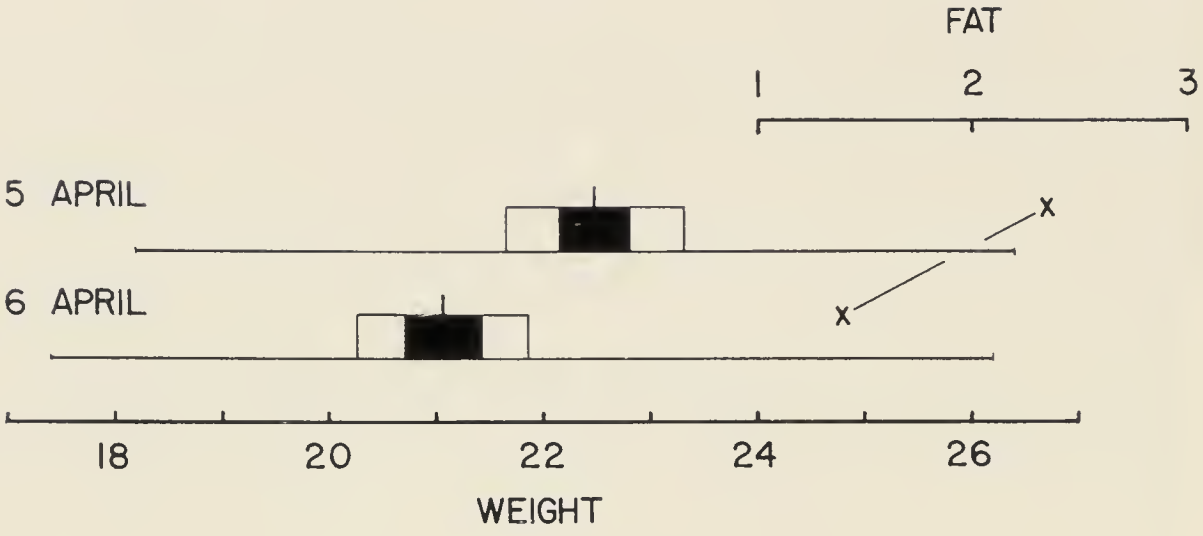

FIG. 1. Song Sparrow weight and fat before and after a night of migration. Weight data in grams (Table 1) are shown by a horizontal line representing range; an open rectangle, one standard deviation; a solid rectangle, three standard errors; and a vertical line, the mean [Mayr and Rosen (1956), based on a modification of Hubbs and Hubbs' modification of Dice and Leraas' method of graphic representation]. Non-overlap of the solid rectangles indicates a significant difference in the graphed means. For either date, mean fat is represented by an X (for explanation, see text).

Class 1 have only traces of fat on the abdomen and in the furculum, while birds in Class 2 have small visceral and abdominal deposits not forming a continuous pad. In Class 3, fat covers the abdomen but is not conspicuously mounded. In Class 4, the furculum is filled and fat on the abdomen is mounded. I have never seen Song Sparrows in our highest fat class, Class 5, in which fat in the furculum is bulging. Table 2 gives a rough comparison of our fat scheme with those of McCabe (1943) and Wolfson (1954*a*). Numbers assigned to fat conditions were averaged to arrive at figures presented in Tables 1–3 and Fig. 1.

The difference between fat on the two days is 0.95, or nearly one fat class, and may be regarded as significant.

It is clear that Song Sparrow weight and fat were higher in a migratory sample before than after a migration had occurred. Comparison of these samples with "resident," or what are actually mixed samples containing both residents and migrants (but with few data from actual pre-flight individuals; Helms and Drury, 1959), is complicated by the lack of proper seasonal data for this region.

Although Nice (1937) and Baldwin and Kendeigh (1938) list mean weights for April in a different geographical population of Song Sparrows, compari-

TABLE 2

COMPARISON OF PUBLISHED FAT CLASSIFICATIONS

Helms and Drury (1959)	McCabe (1943)	Wolfson (1954a)
0	No Fat	None
+		
−	Little	
1		Little
+		
−	Moderate	
2		
+		
−	Fat	
3		Medium
+		
−	Very Fat	
4		
+		
−	Excessively Fat	Heavy
5		
+		

sons with these data might be instructive. Recalculating Nice's (1937) data to arrive at a mean April weight for both sexes of 21.99 grams, with an estimated standard deviation of 1.97 grams (Snedecor, 1956:37–38; considering the largest sample size of 50 given in his Table 2.2.2, p. 38, compared with this sample of 150, and the S.D. values in this paper, this point estimate is probably generous), it is possible to perform *t*-tests. These indicate that morning mean weights of the April 5 sample are significantly higher than April means ($P = .025 - .010$), and weights of the April 6 sample are significantly lower ($P = <.001$). Baldwin and Kendeigh (1938) list a mean weight of 21.4 grams for 464 adult Song Sparrows in April. Assuming that S.D. = 1.9 grams. mean weight on April 5 is significantly above the mean monthly weight ($P = <.001$), while the April 6 mean is not significantly different ($P = .20–.10$).

In connection with these comparisons, both diurnal and seasonal variation must be borne in mind. The monthly means used are based on weights throughout the day whereas means for April 5 and 6 are only morning weights. Normal diurnal weight increases would tend to increase differences between April 5 weights and the means used for comparison, while decreasing the difference between the April 6 weights and those means. Seasonal varia-

tion would, however, reverse this tendency since weights are dropping during April (Nice, 1937), and these samples were obtained near the beginning of the month. Thus, these comparisons are only indicative.

I suspect, however, that if local morning averages for the first half of April were available for comparison, April 5 weights would be significantly higher. I believe that weight and fat on this date do indeed represent a true preparation for migratory flight.

Tree Sparrow

This view is supported moreover, by data on migrant Tree Sparrows from the same migration at Plum Island, although these data are based on a much smaller sample. These are summarized in Table 3 and include only morning weights.

Table 3

Tree Sparrow Weight and Fat Before and After a Night of Migration

	Sample Size	Mean Weight	Range	S. D.	S. E.	Fat
Pre-flight Data (April 5, 1958)	7	20.13	19.0–22.5	1.20	0.45	2.86
Post-flight Data (April 6, 1958)	4	18.98	17.9–20.0	—	—	1.75

Key: See Table 1.

The difference between these mean weights, 1.15 grams, is not significant ($P = .20 - .10$), probably due to the small samples. This difference between pre-flight and post-flight individuals is, however, on the same order of magnitude as in the Song Sparrow and is certainly suggestive.

Helms and Drury (1959) do have mean weights from the same period which may be compared with these data. The mean daily weight for the first two weeks of April, 19.73 grams, is significantly below the April 5 weights (a total of 13 weights for April 5 averaged 20.61; S.D. = 1.18; S.E. = 0.33 gram; $P = .025$). Morning weights on April 6 differ insignificantly from morning means for the half-month period (19.66 grams; $P = .40 - .20$).

These statistical comparisons are free of the objections raised by the Song Sparrow comparisons, and indicate that Tree Sparrows may show a weight and fat preparation for migratory flight.

The similarity of Song and Tree Sparrow weight and fat is striking and indicates the following: (1) Energy reserves measured by body weight and visible fat are greater in these sparrows prior to a migratory flight than after. (2) These sparrows may show a true migratory preparation involving increased lipid reserves and body weight when compared with predominantly resident samples.

Discussion

Baumgartner's (1938) weight data on Tree Sparrows have been cited frequently as evidence for premigratory or migratory increases. Study of her graphed data (p. 608) compared with similar graphs in Helms and Drury (1959), and her own separation of resident and migratory periods, indicates that migratory weights are lower than the winter maximum. The heaviest samples during migration (March 15, 20–25) are significantly less than the weights of February 26 and March 4–10 during the winter peak ($P = < .001$). However, the lateness of this peak in the winter is puzzling, and it precedes migration directly. Due to the lack of temperature data and the relatively small samples, however, interpretation of this peak as premigratory seems inadvisable.

In fact, the entire picture of weight and fat variation in Tree Sparrows differs sufficiently from that of Slate-colored Juncos to warrant a brief discussion. In the former species, only two birds (in over 3000 records) have been seen with Class 5 fat. Migrant juncos, on the other hand, commonly had Class 5 fat. Differences in mean weights between successive fat classes decrease with increasing fat classes in Tree Sparrows (1.36, 0.96, 0.72 grams, respectively), and inversely in juncos (0.65, 1.42, 1.27, 1.59 grams, respectively; Fig. 3, Helms and Drury, 1959). Tree Sparrows showed no peaks in mean weights clearly associated with migration, whereas Slate-colored Juncos did.

On this basis, I propose two different patterns of weight–fat variation in emberizines. Type I variation (Slate-colored Junco) may be characterized by: (1) significant weight and fat increases evident in spring migratory periods in wild populations, if these populations are migratory; (2) heavy fat deposition (Class 5) regularly found in migrant individuals; and (3) mean weight differences between fat classes increasing with increasing fat class. The sex of birds showing this type of variation may be determined at all times of the year by the cloacal protuberance (Drost, 1938; brief discussion below). This may be contrasted with Type II variation (Tree Sparrow), characterized by: (1) insignificant weight and fat increases in grouped mean data during migratory periods in wild populations; (2) heavy fat deposition (Class 5) rarely or never found; and (3) differences in mean weights between fat classes decreasing with increasing fat class. In my experience the sex of birds in this type may be reliably determined by the cloacal protuberance only during the breeding season.

Since these patterns are based on findings in two species, it would be well to see if other emberizines fit either pattern. My own observations of captive and wild White-throated Sparrows indicate that they are typical Type I

variants. Wolfson's (1954*a*:419) data on this species verifies condition (3) of Type I if differences in our fat classifications are borne in mind, and Odum (1949) and Odum and Perkinson (1951) verify conditions (1) and (2) for this species. White-throats can be sexed at any season by the cloacal protuberance.

My observations on captive White-crowned Sparrows (*Zonotrichia leucophrys*) and Oregon Juncos (*Junco oreganus*) indicate that they also are Type I variants.

Nice's (1937, 1946) weight data suggest that Song Sparrows fit condition (1) of Type II variation. It should be noted that this condition applies to grouped mean data in wild populations and does not preclude significant weight increments in migratory individuals prior to flight as reported in this paper. My own field observations indicate that condition (2) is satisfied for this species. Although limited data on fat in Song Sparrows are available, it seems that condition (3) is also met. In the Tree Sparrow, a Type II variant, the mean weight difference between Classes 1 and 2 fat is 1.36 grams. In the Song Sparrow samples considered here, in which the fat differences are essentially those between Classes 1 and 2, the mean weight difference is 1.41 grams, in close agreement with the Tree Sparrow increment. Limited data on higher fat classes indicate mean differences do decrease, and condition (3) is fulfilled. I am unable to sex Song Sparrows in spring by the cloacal protuberance.

My field data suggest that Type II variation is also shown by Fox Sparrows (*Passerella iliaca*), Swamp Sparrows (*Melospiza georgiana*), and possibly by Savannah Sparrows (*Passerculus sandwichensis*). Data on one captive female Lark Sparrow (*Chondestes grammacus*) suggest either Type II or a third type of variation.

Whether these particular types and conditions of variation are upheld or not, it seems evident that there are at least two distinct physiological patterns of weight and fat variation in different species of emberizines.

The Cloacal Protuberance.—Since the usefulness of the cloacal protuberance in determinations of sex of non-breeding birds is frequently overlooked, and because this usefulness is different in the two variant types, a brief discussion is in order. Salt (1954) and Wolfson (1952, 1954*b*) have described the anatomy and function of the breeding protuberance. Drost (1938), after long study of the protuberance, concluded that it could be used satisfactorily to sex many non-breeding species of European birds. In general, the male protuberance, which contains paired seminal vesicles, forms a distinctly angular junction with the abdomen and has a more or less flattened tip. The female protuberance, lacking the sac-like seminal vesicles, forms a curved junction with the abdomen and has a more or less pointed tip. The male protuberance is generally larger but not consistently so (Helms, 1959 MS). When determination is questionable, the bird is usually a female. Errors are most likely in juvenile birds, and in adults following the gonadal regression into early post-nuptial molt, and in very fat birds in which the

mass of subcutaneous abdominal lipid often makes the female protuberance look angular. Plumage characters and measurements should be used to check protuberance determinations.

Sexing error in Type I variants is less than 10 per cent on first handling and can be reduced to less than one per cent with subsequent determinations. I have found also that angularity of the protuberance may be used to determine gonadal regeneration in incomplete castrates.

Although Type II variants show protuberance differences, they are not consistently reliable. Sexing error by the protuberance alone is about 40 per cent and shows no reduction with subsequent determinations. The seminal vesicles of non-reproductive Trec Sparrows are less than half as large as those of White-throated Sparrows (1.4–2.0 mgm., compared with 5.5–7.4 mgm.), are slimmer, and are more tangentially oriented to the cloaca.

It should be noted that all species mentioned have bulbous type protuberances (Wolfson. 1954*b*), with the possible exception of the Lark Sparrow, whose type is unrecorded.

I have mentioned the protuberance in this paper because of the possibility of functional indications with weight and fat variation. Condition (3) of the respective types probably has an anatomical basis in the relative amounts of fat deposited in various body areas. A study such as Odum and Perkinson's (1951) would be desirable on a Type II variant. Conditions 1 and 2 would reflect these differences if such exist. However. the development of the seminal vesicles, which are responsible for the appearance of the male protuberance, is under the control of androgens (Marshall, 1955) and may be used as a crude indicator of androgen secretion (Salt, 1954). Fat deposition is essentially different in relative distribution and amount during migratory periods (Odum and Perkinson, 1951) and under a different physiological control (Helms and Drury, 1959). It can be influenced by the sex steroids (Wagner. 1956). These facts suggest that the lower level of androgen secretion indicated by the smaller seminal vesicles of non-breeding Type II variants might influence the pattern of weight and fat variation during non-breeding periods. Therefore, different hormonal levels, timing, balances, and/or sequences during migration, coupled with different morphology of the lipid reserves, might account for the differences in variation patterns.

Summary

1. Song Sparrow and Tree Sparrow samples taken before and after a night of coastal migration show that pre-flight individuals have significantly higher body weight and fat than post-flight individuals. Weight differences before and after the flight were 1.41 grams in Song Sparrows and 1.15 grams in Tree Sparrows. Fat was one class lower after the flight.

2. Comparison of these samples with monthly or half-monthly means obtained from "mixed" populations suggest that pre-flight individuals show a true migratory preparation which is not reflected in the mean values over longer periods in these two species.

3. Two patterns of weight and fat variation in emberizines are proposed with criteria for each: Type I variation is shown by Tree Sparrows, and Type II variation by Slate-colored Juncos.

4. Determination of sex using the cloacal protuberance is possible at all

seasons in Type I variants, but only during the breeding season in Type II variants.

Literature Cited

Baldwin, S. P., and S. C. Kendeigh
1938 Variations in the weight of birds. *Auk*, 55:416–467.

Baumgartner, A. M.
1938 Seasonal variations in the Tree Sparrow. *Auk*, 55:603–613.

Drost, R.
1938 Geschlechtsbestimmung lebender Vögel nach der Form der Kloakengegend. *Vogelzug*, 9:102–105.

Farner, D. S.
1955 The annual stimulus for migration: experimental and physiologic aspects. *In* Recent studies in avian biology. Univ. Ill. Press, Urbana. pp. 198–237.

Helms, C. W.
1959 MS Sexual determination by the cloacal protuberance in some migrant passerines.

Helms, C. W., and W. H. Drury, Jr.
1959 Winter and migratory weight and fat: field studies on some North American buntings. *Bird-Banding*, 30: in press.

Marshall, A. J.
1955 Reproduction in birds: the male. *Mem. Soc. Endocrinol.*, 4:75–93.

Mayr, E., and C. B. Rosen
1956 Geographic variation and hybridization in populations of Bahama snails (*Cerion*). *Amer. Mus. Novitates*, 1806:1–48.

McCabe, T. T.
1943 An aspect of the collector's technique. *Auk*, 60:550–558.

Nice, M. M.
1937 Studies in the life history of the Song Sparrow. I. *Trans. Linn. Soc. N. Y.*, 4: 247 pp.
1946 Weights of resident and winter visitant Song Sparrows in central Ohio. *Condor*. 48:41–42.

Odum, E. P.
1949 Weight variations in wintering White-throated Sparrows in relation to temperature and migration. *Wilson Bull.*, 61:3–14.

Odum, E. P., and J. D. Perkinson
1951 Relation of lipid metabolism to migration in birds; seasonal variations in body lipids of the migratory White-throated Sparrow. *Physiol. Zool.*, 24:216–230.

Salt, W. R.
1954 The structure of the cloacal protuberance of the Vesper Sparrow (*Pooecetes gramineus*) and certain other passerine birds. *Auk*, 71:64–73.

Snedecor, G. W.
1956 Statistical methods. (5th ed.) Iowa State College Press, Ames. 534 pp.

Wagner, H. O.
1956 Die Bedeutung von Umweltfaktoren und Geschlechtshormonen für den Jahresrhythmus der Zugvögel. *Zeits. vergl. Physiol.*, 38:355–369.

Wolfson, A.
1945 The role of the pituitary, fat deposition and body weight in bird migration. *Condor*, 47:95–127.

1952 The cloacal protuberance—a means for determining breeding condition in live male passerines. *Bird-Banding*, 23:159–165.

1954*a* Weight and fat deposition in relation to spring migration in transient White-throated Sparrows. *Auk*, 71:413–434.

1954*b* Notes on the cloacal protuberance, seminal vesicles, and a possible copulatory organ in male passerine birds. *Bull. Chicago Acad. Sci.*, 10:1–23.

HATHEWAY SCHOOL OF CONSERVATION EDUCATION, DRUMLIN FARM, SOUTH LINCOLN, MASSACHUSETTS, MARCH 14, 1959 (SUBMITTED ORIGINALLY, DECEMBER 15, 1958)

NEW LIFE MEMBER

Karl H. Maslowski, an active member of the Wilson Ornithological Society since 1934, became a Life Member this year. He lives in Cincinnati, Ohio, with his wife, three sons, and one daughter. Mr. Maslowski is a motion picture producer and lectures for the National Audubon Society. His principal interest in ornithology is motion picture studies of life histories. He has been a nature columnist for the *Cincinnati Enquirer* for 23 years, and has written popular articles (many illustrated by his fine photographs) for many magazines and special publications. He has published notes in *The Wilson Bulletin*, *The Auk*, and *Journal of Mammalogy*.

Karl is also a member of the A. O. U. and the American Society of Mammalogists, and has been a board member of the Cincinnati Society of Natural History Museum and a Trustee of the Cincinnati Zoological Society for about 10 years.

HOMING OF PURPLE MARTINS[1]

BY WILLIAM E. SOUTHERN

MANY papers dealing with homing and orientation have been published. Relatively few of these papers pertain to homing ability of passerines during the breeding season. With this in mind I conducted a series of 16 homing experiments on Purple Martins (*Progne subis*) in the summer of 1958 at the University of Michigan Biological Station, Cheboygan County, Michigan. A colony of 60 pairs of martins nested in four houses along the shore of Douglas Lake.

I trapped the martins in nylon snares, made of six-pound-test monofilament fishing line, placed at the entrances to the nests. The loop of the snare surrounded the entrance hole and was held in position by a tack. When the adult entered the nest it passed through the noose which closed around its neck. The weight of the bird kept the noose tight, thus preventing escape. The birds struggled only slightly and sometimes hung motionless until I released them. No birds were injured by the snares; all birds trapped and used in experiments survived throughout the summer. Since the females did most of the nesting tasks they entered the compartments more readily, hence only two males were captured during the summer. Only one member of a pair was used in any one trial. A different bird was used for each trial.

Birds were transported to the point of release by automobile. They were carried in closed cigar boxes, and the periods of confinement ranged from 15 minutes to 23.8 hours.

Each experimental bird was color-marked in such a manner that I could distinguish it from all other martins in the colony. However, these color markings were of little use at a distance. Therefore, I waited until I definitely saw the marked bird return to the nest compartment before I considered it as a return. I refrained from marking the flight feathers with enamel because it might have interfered with flight. The enamel was placed on the crown, rump, breast, back, throat, or crissum. Seven different colors of enamel were used. For more permanent identification a U.S. Fish and Wildlife Service numbered aluminum band was placed on one leg of each bird and a plastic color band on the other.

I wish to express my appreciation to Harrison B. Tordoff for his useful suggestions during this project, to Donald Moline and other Station personnel for aid in dispatching and observing experimental birds, and to Edmund J. Tucker of the Michigan Conservation Department for observations on one bird at the release point. The expenses of this project were met by a National Science Foundation grant.

[1] Contribution from the University of Michigan Biological Station.

Experiments

Adult martins were transported to distances ranging from 1.75 miles to 234 miles (air distance). The length of time required for returns varied greatly. In several cases the precise time of return could not be determined. Furthermore, some homing birds probably were in the vicinity of the colony for some time without returning to the nest and therefore passed unnoticed. The experimental martins were usually extremely nervous after returning and hesitated to approach the nest compartment. They closely examined the entrance before they entered.

Weather conditions during these experiments varied greatly. Birds were released during rain storms, cloudy periods, clear sunny days, clear starlit nights, and cloudy nights. Wind velocity varied from two or three mph up to 28 mph. Climatological data for the release points (obtained from the U.S. Weather Bureau or local authorities) appear in Table 1.

I released birds in various directions from the home colony. Birds were liberated north of the Straits of Mackinac, on the Wisconsin side of Lake Michigan, and in the interior of the Lower Peninsula of Michigan.

The first five martins were discharged close to the Biological Station (1.75 to 10 miles) and were apparently presented with no difficulty in homing (see Table 2). This was probably familiar territory to the birds and perhaps much of it had been covered during normal feeding activities. The longer flights probably presented a greater challenge to the birds because of the increased likelihood that they must fly over unfamiliar territory, especially from release points north and west of home.

Number 6.—Female released in Grand Rapids, Michigan, at 12:00 noon, June 28. There was a strong wind (west-southwest 15 mph). She was not seen at the Station for 25.5 hours. Possibly the bird returned sooner but was not noticed or did not enter the house.

Number 7.—Male released at 8:10 p.m., June 28 at Charlevoix, Michigan. I released the bird near the shore of Lake Michigan and within the boundaries of another martin colony. He ignored the other martins and apparently they did not respond to his presence. The male performed the usual circling and gaining of altitude. The circles increased in diameter as he gained altitude. Never did the circle extend over the lake. After a few minutes I lost sight of the bird. I was not present at the Station to record the exact time of return, but he was present at the nest at 7:00 p.m., June 29.

Number 8.—This female was released at Petoskey, Michigan, at 7:45 p.m., June 28. She was not observed at the Station that evening but was seen at 7:00 a.m. the following day. She probably returned the previous evening or night. Upon release, near Little Traverse Bay, she gained altitude, circled once and headed directly toward the Station.

Table 1

Weather Data at Purple Martin Release Points in 1958

Release Point	Bird No.	Date	Temp. (°F.) High	Temp. (°F.) Low	Precipitation (inches)	Wind Dir.	Wind Speed (mph)	Sunshine (min.)	Sky Cover (per cent)	Visibility (miles)	Remarks
Pellston	1	June 25	59*	47*	trace	SW	18–20*	—	100	—	—
Reese's Bog	2	June 25	59*	47*	trace	SW	18–20*	—	100	—	—
Riggsville	3	June 25	59*	47*	trace	SW	18–20*	—	100	—	—
Cheboygan	4 & 5	June 27	74	48	0	WNW	11–15	60	0	15	clear
Grand Rapids	6	June 28	81	59	0	WSW	12–15	—	—	15	partly cloudy
Charlevoix	7	June 28	77	60	0	SSW	4–7	—	—	20	clear
Petoskey	8	June 28	75	52	0	SSW	4–7	—	—	20	clear
Escanaba	9	July 1	73		.77	S	12–18	0	100	0–2	fog
Lena, Wis.	10	July 1	85	71	trace	WSW	20–28	—	—	10	partly cloudy
Ann Arbor	11	July 7	81	67	0	NW	12	0	100	—	cloudy, wind variable
Flint	12	July 7	79	64	.28	SW	2–5	—	100	15	fog earlier, cloudy, wind variable
Ann Arbor	13	July 8	78	63	0	NW	14	—	80	—	cloudy
Sleeper Lake	14	July 13	79	66	0	NW	8	—	30	7	—
Michelson	15	July 18	68	49	trace	W	0–2	—	—	—	clear by night
Grayling	16	July 18	66	46	trace	W	0–3	—	—	—	storm front to the north (20 miles)

* Estimates by the observer.

Table 2

Data Pertaining to 16 Homing Flights by Purple Martins in 1958

Bird No.	Sex	Nest Contents	Release Point	Mileage	Direction	Released		Returned		Maximum Time to Return
						Date	Time	Date	Time	
1	♀	eggs	Pellston	6	W	June 25	12:32 p.m.	June 25	1:20 p.m.	.8 hr.
2	♀	eggs	Reese's Bog	1.75	S	June 25	3:15 p.m.	June 25	3:37 p.m.	.3 hr.
3	♀	eggs	Riggsville	4	E	June 25	4:20 p.m.	June 25	4:31 p.m.	.2 hr.
4	♀	eggs	Cheboygan	9	ENE	June 27	1:21 p.m.	June 27	2:05 p.m.	.7 hr.
5	♀	eggs	Cheboygan	10	ENE	June 27	1:30 p.m.	June 27	3:50 p.m.*	1.5 hrs.
6	♀	eggs & young	Grand Rapids	202	SSW	June 28	12:00 noon	June 29	1:30 p.m.*	25.5 hrs.
7	♂	young	Charlevoix	32.5	WSW	June 28	8:10 p.m.	June 29	7:00 a.m.*	22.8 hrs.
8	♀	young	Petoskey	19.5	WSW	June 28	7:45 p.m.	June 29	7:00 a.m.*	23.3 hrs.
9	♀	young	Escanaba	117	NNW	July 1	1:00 p.m.	July 2	12:00 noon	23.0 hrs.
10	♀	young	Lena, Wisc.	169	WSW	July 1	4:00 p.m.	July 2	10:30 a.m.	18.5 hrs.
11	♀	young	Ann Arbor	234	SSE	July 7	10:40 p.m.	July 8	7:15 a.m.*	8.6 hrs.
12	♀	young	Flint	185	SSE	July 7	6:45 p.m.	July 8	7:15 a.m.*	12.5 hrs.
13	♀	young	Ann Arbor	234	SSE	July 8	6:50 a.m.	July 8	5:30 p.m.*	10.7 hrs.
14	♀	young	Sleeper Lake	77	NNW	July 11	9:00 p.m.	July 13*	—	—
15	♀	young	Michelson	83	S	July 18	10:30 p.m.	July 21	6:30 a.m.*	—
16	♂	young	Grayling	62	S	July 18	8:05 p.m.	July 21*	—	—

* Perhaps returned earlier but not recorded.

Number 9.—This female was released at Escanaba in the Upper Peninsula of Michigan at 1:00 p.m., July 1. She remained in the area until 3:35 p. m. (observed by E. J. Tucker). This delay in departure was probably brought about by the locality being blanketed with fog. She had definitely returned and entered the house by noon on July 2. However, I thought I saw her at 7:15 p.m. on July 1.

Number 10.—Female released in Lena, Wisconsin, at 4:00 p.m. on July 1. She performed the usual circling behavior upon release and gained altitude. Perhaps this bird encountered fog when she neared Lake Michigan. She returned to the nest at 10:30 a.m., July 2. I believe that she had just returned from the homing flight since she seemed fatigued and unsteady. She landed on the perch outside the nest, wobbled back and forth, and finally fell. She caught herself on another perch located about 10 inches below. There she perched and continued to wobble about. At 12:30 p.m. she acted more stable but still did not seem completely normal. Later in the afternoon she appeared much stronger. It would be interesting to know the direction taken by this bird upon reaching the Wisconsin shore of Lake Michigan. Did she follow the shore line or did she fly directly across?

Number 11.—Female released in Ann Arbor at 10:40 p.m., July 7. She had returned to the Station and was feeding young at 7:15 a.m., July 8. From her behavior, I am certain that she had been in the area for some time. As mentioned earlier, the birds always seemed suspicious after returning from a homing flight. When I first saw this bird she did not hesitate in the least before entering the nest compartment.

She made the flight of 234 miles in no more than 8.6 hours. This is an average speed of 27.2 mph. To have established this average the martin must have exceeded this speed considerably at times, especially if she wandered in search of landmarks. However, this rate of return seems to exclude much wandering. Meinertzhagen (1921:230) had comparable results with Barn Swallows (*Hirundo rustica*). He conducted experiments in East Africa, and one bird averaged 37.75 mph, and another 34 mph. His record of an earlier flight of a swallow from Paris to Roubaix at a speed of 106 mph is open to doubt, as he pointed out. Rüppell (in Matthews, 1955:41) also conducted experiments with Barn Swallows. His birds averaged only 9 to 10 mph in homing. There are records of non-passerine species homing at rates of 8 to 37 mph.

Most interesting is the fact that Number 11 made a nocturnal homing flight. Supposedly, Purple Martins are diurnal migrants and therefore, as discussed by Lakhovsky (in Mattingley, 1946:513), should not be capable of nocturnal orientation. The fact that martins may occasionally migrate by night is suggested by Trautman's statement (1940:307) referring to a flock of 150 birds that arrived in his area in the early afternoon and left at dark. He referred to

this as "a rather curious performance for these supposedly day migrants." Many observers, including the Andersons (1946:140–141), Cater (1944:15–18), Higman (1944:43–44), and Woodbury (1946:42), have reported large flocks of martins preparing to roost for the night. Estimates of up to 25,000 martins have been given for such roosts. None of these observers mentions checking on these flocks at night to see if the birds were still present. Smith (1908:41–43) watched a diurnal migratory flight of more than 10,000 Purple Martins at Macatawa, Michigan.

Since the sky was entirely overcast (a second cloud layer being above the first), it seems unlikely that celestial navigation was possible.

Number 12.—Female released in Flint, Michigan, at 6:45 p.m., July 7. Upon release she flew south one block and then headed northwest. She had returned to the Station by 7:15 a.m., July 8. This bird probably returned earlier because she had lost all suspicion of the nest site. Part of this flight must have been performed at night.

Number 13.—Female released in Ann Arbor, Michigan, at 6:50 a.m., July 8. This bird had been captive in a darkened container for 23.8 hours. She returned to the Biological Station sometime during the afternoon of July 8. I was prevented from checking on the return until 5:30 p.m., and she was present at that time. Apparently she made this return flight in a time comparable to bird Number 11.

Number 14.—Female released at Sleeper Lake, Luce County, in the Upper Peninsula of Michigan at 9:00 p.m., July 11. She circled clockwise and then counter clockwise while gaining altitude and then headed southeast. I did not see her at the Station until the afternoon of July 13, although I made periodical checks during each day of her absence.

Number 15.—Female released at Michelson, Roscommon County, Michigan, at 10:30 p.m. on July 18. At the release point the sky was clear of clouds, and there was little wind. A storm center lay between the bird and home at the time of release. She did not return until 6:30 a.m. on July 21.

Number 16.—Male released at Grayling, Michigan, at 8:05 p.m., July 18. He circled high for about ten minutes before I lost sight of him. He was confronted with the same storm center as bird Number 15. I failed to note him at the Station until 6:30 a.m.. July 21.

Discussion

To my knowledge this was the first time Purple Martins were used in homing experiments. Other members of the Hirundinidae have been used. These include the Bank Swallow (*Riparia riparia*), Rough-winged Swallow (*Stelgidopteryx ruficollis*), Barn Swallow, and the House Martin (*Delichon urbica*). These species have homed in trials ranging from four miles to the amazing

distance of 1150 miles (see Table 3). .The percentage of returns has varied greatly. Rarely did investigators that used more than four birds find a return rate higher than 50 per cent. It is therefore of interest to note that all 16, or 100 per cent, of my Purple Martins returned from the point of release.

TABLE 3

HOMING DATA PERTAINING TO THE HIRUNDINIDAE

Species	Trials	Returns	Per Cent Returned	Distances (miles)	Sources
Bank Swallow	35	13	37	4–142	Loos (1907), Matthews (1955)
Rough-winged Swallow	3	3	100	4–33	Gillespie (1934)
Barn Swallow	198	92	47	4–1150	Dupond (1935), Keller (1926), Lack (1938), Lockley (1942), Loos (1907), Rüppell (1934, '35, '36, '38), Wodzicki (1934, '38, '39), Wojtusiak (1937)
Purple Martin	16	16	100	1.75–234	Southern (present study)
House Martin	35	12	34	7–450	Matthews (1955), Rüppell (*op. cit.*), Wodzicki (1934)

SUMMARY

During the summer of 1958, 16 Purple Martins were used in a series of homing experiments at the University of Michigan Biological Station.

The birds were released at distances ranging from 1.75 miles to 234 miles. The rate of return varied greatly. The most rapid return was a nocturnal flight of 234 miles in 8.58 hours.

One hundred per cent of the martins returned from the homing flights. This material has been compared with the available homing data pertaining to the Hirundinidae.

LITERATURE CITED

ANDERSON, A. H., AND A. ANDERSON

1946 Notes on the Purple Martin roost at Tucson, Arizona. *Condor*, 48:140–141.

CATER, M. B.

1944 Roosting habits of martins at Tucson, Arizona. *Condor*, 46:15–18.

DUPOND, L.

1935 OEurre du baguage des oiseaux en Belgique. Exercise 1934. *Gerfaut*, 25:49–115.

GILLESPIE, J. A.

1934 The homing instinct in the Rough-winged Swallow. *Bird Banding*, 5:43–44.

HIGMAN, H. W.

1944 Autumn roosting of Purple Martins within the city limits of Seattle, Washington. *Murrelet*, 25:43–44.

KELLER, G.

1926 Quoted Heinroth (1926). *Jour. f. Ornith.*, 74:561.

Lack, D., and R. M. Lockley
1938 Skokholm Bird Observatory homing experiments. *Brit. Birds*, 31:242–248.
Lockley, R. M.
1942 Shearwaters. J. M. Dent & Sons, London.
Loos, C.
1907 Ein Beitrag zur Frage über die Geschwindigkeit des Fluges der Vögel. *Ornith. Monatsb.*, 15:17–29.
Matthews, G. V. T.
1955 Bird navigation. Cambridge Univ. Press, Cambridge, England.
Mattingley, A. H. E.
1946 Orientation in birds. *Ibis*, 88:512–517.
Meinertzhagen, R.
1921 Some preliminary remarks on the velocity of migratory flight among birds, with special references to the Palearctic Region. *Ibis*, 3:228–238.
Rüppell, W.
1934 Verfrachtungsversuche am Star (*Sturnus vulgaris*) u. a. Arten von W. Schein-Winsen. *Vogelzug*, 5:53–59.
1934 Heimfinde-Versuche mit Rauchschwalben (*Hirundo rustica*) und Mehlschwalben (*Delichon urbica*) von H. Warnat (Berlin-Charlottenburg). *Vogelzug*, 5:161–166.
1935 Heimfindeversuche mit Staren, 1934. *Jour. f. Ornith.*, 83:462–524.
1936 Heimfindeversuche mit Staren und Schwalben, 1935. *Jour. f. Ornith.*, 84:180–198.
1938 Ergebnis eines Heimfindeversuches mit Aufgezogenen Staren. *Vogelzug*, 9:18–22.
Smith, F.
1908 A migration flight of Purple Martins in Michigan in the summer of 1905. *Wilson Bull.*, 20:41–43.
Trautman, M. B.
1940 The birds of Buckeye Lake, Ohio. Univ. of Michigan Press, Ann Arbor. 466 pp.
Wodzicki, K.
1939 Untersuchungen über die Orientierung und Geschwindigkeit des Fluges bei Vogeln. V. Weitere Versuche an Störchen. *Jour. f. Ornith.*, 87:99–114.
Wodzicki, K., and R. J. Wojtusiak
1934 Untersuchungen über die Orientierung und Geschwindigkeit des Fluges bei Vogeln. I. Experimente an Schwalben (*Hirundo rustica* L.). *Acta Orn. Mus. Zool. Pol.*, 1:253–274.
Wodzicki, K., W. Puchalski, and H. Liche
1938 Untersuchungen über die Orientierung und Geschwindigkeit des Fluges bei Vogeln. III. Untersuchungen am Störchen (*Ciconia c. ciconia*). *Acta Orn. Mus. Zool. Pol.*, 2:239–258.
Wojtusiak, R. J., K. Wodzicki, and B. Ferens
1937 Untersuchungen über die Orientierung und Geschwindigkeit des Fluges bei Vogeln. II. Weitere Versuche an Schwalben: Beeinflussung durch Nachtzeit und Gebirge. *Acta Orn. Mus. Zool. Pol.*, 2:39–61.
Woodbury, A. M.
1946 Huge migratory flock of Purple Martins in Utah. *Condor*, 48:42.

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THE DEVELOPMENT OF SOUND-SIGNAL PREFERENCES IN DUCKS

BY PETER H. KLOPFER

In an attempt to analyze one aspect of the ontogeny of behavior, a study was made of the manner in which young ducks and geese developed response tendencies directed toward specific sound-signals (Klopfer, 1957, and in press). It was found that the surface-nesting species which were studied (principally Mallards, *Anas platyrhynchos*, and Redheads, *Aythya americana*), if reared under conditions of relative auditory isolation, tended to approach most rhythmic, repetitive signals without discrimination. This behavior was not altered by intermittently exposing the birds to recordings of a particular signal at different ages before and after hatching. A specific response could be established, however, by presenting the sound while the bird was following a moving model or the experimenter. In at least one hole-nesting species, the Wood Duck (*Aix sponsa*), a different pattern was obtained. This species showed no tendency to approach rhythmic signals when the individuals tested were reared as auditory isolates, and this was also true for the birds which had been exposed to the moving experimenter plus a sound. Those birds which had been exposed to the sound alone, however, very rapidly developed a tendency to approach that sound to the exclusion of others. Individuals of a domestic strain of Muscovy Duck (*Cairina moschata*), which were largely nonvocal, could not be made to approach the sound signals irrespective of the treatment accorded. In all these instances the manner in which responses to auditory signals are established is related in a fairly simple way to the nesting habits and social organization of the different species. Of course, such a correlation does not in itself shed light on the causal relations, e.g., evolutionary development, of the traits in question.

In the present study I was concerned to re-examine one of the hypotheses of my previous work (*ibid.*). In particular, I wished to know whether the type of auditory imprinting shown by the Wood Duck would be shared by other hole-nesting species which are not members of the tribe Cairinini (Delacour and Mayr, 1945). For these purposes the Common Sheldrake (*Tadorna tadorna*, tribe Tadornini) was selected, for it was reasonably abundant locally and habitually nests in deep rabbit burrows.

Acknowledgments

This work was carried out at the Madingley Field Station for the Study of Animal Behaviour (Cambridge University) during the tenure of a U. S. Public Health Service Fellowship. Facilities were generously provided by Drs. W. H. Thorpe and R. A. Hinde. I am much obliged to Dr. E. A. Duffy of the Nature Conservancy, and particularly to Mr. R. Chestney, warden at Scolt Head Island, for provision of the sheldrakes. Thanks are also due to Dr. R. A. Hinde for having made suggestions regarding the manuscript.

Methods

The birds were arbitrarily distributed among three training groups which were treated as follows:

Isolates—Fifteen birds were incubated and hatched in an incubator situated within a sound-proof room (Thorpe and Hinde, 1956). These ducklings were kept in groups of 3 to 5 and heard no sounds other than those they themselves produced until the time at which testing took place, when the birds were between 18 and 26 hours of age.

Sound Only—Ten birds, from the moment of emergence until 10 to 14 hours of age, were exposed to a recorded sound-signal of three minutes' duration at intervals of one to two hours. The total time of exposure was 30 minutes. Each bird was exposed to one of two possible sounds: a slowly repeated monosyllabic *kom kom kom* or a more rapid and higher *pip pip pip*. Audiospectrographic analysis had previously shown that these two calls roughly resembled the two principal types of calls made by females of several tribes when leading young (Klopfer, 1957). These birds were tested 8 to 12 hours after the last exposure.

Following with Sound—Ten birds were allowed to follow the experimenter as soon as they proved able to walk, which was generally between 6 and 10 hours after emergence. At the same time they were exposed to one of the two sounds described above. Originally it was intended to have these birds follow a loudspeaker and model which were suspended from a pulley system, but the birds all proved to follow far more satisfactorily an articulated object such as the experimenter. Each following exercise took 5 to 10 minutes, with a maximum total of 30 minutes of exposure. A few good followers were exposed for only 20 minutes. Testing took place after an interval of 8 to 12 hours after the last exposure.

For the tests, the birds were individually introduced into a four-foot square box from each corner of which a smaller 6 × 6 × 12-inch box radiated. Each of the latter boxes had an opaque cover and, at the outer end, a loudspeaker. The central box had a black gauze cover so that, when lighted from within and placed in a darkened room, it was possible to observe the birds within without their being aware of the observer's presence. Sixty seconds after a bird had been introduced into the center of this apparatus, during which time it either sat quietly where it was placed or else wandered slowly about the central box, a sound signal was played through one of the speakers and the response of the bird noted. Although, on the basis of my earlier work, different types of responses were expected, the sheldrakes either went to the source of the sound within two minutes of its onset (and usually within 30 seconds, alternately emitting pleasure and distress notes, then entering the small box and pecking against its sides), or else they continued as they had been prior to the onset of the sound signal. In a few instances, the bird scurried quietly into one of

the boxes away from the sound source and crouched in a corner. This occurred a similar number of times before the onset of the sound signal. Whenever a bird had entered a small box, it was removed and replaced in the center of tht apparatus before the next signal was presented.

The order in which the sounds were presented was systematically varied, as was the direction from which the sounds originated.

In addition to the sound signals described above, *kom* and *pip*, a disyllabic, slowly repeated *hel-lo* was also used, the pitch falling sharply from the first to the second syllable. This sound crudely mimics some of the more complex notes of male Wood Ducks, and species with similar whistled notes.

The previous experiments had demonstrated that during the period of a 30-minute test, changes in responsiveness were generally slight, as were the effects of experiences within the test apparatus. At that time, birds had been tested with a number of different sound-signals, including recordings of certain of the calls of various species of ducks and geese. In this instance, the lower temperatures which prevailed called for a significant reduction in the duration and number of the tests. As a consequence, the interpretation of the data must be qualified in certain ways (see below).

Ages were arbitrarily designated to be the number of hours elapsed from the moment of total emergence from the shell. This procedure is undoubtedly responsible for a certain amount of variability in the behavior of ducklings allegedly of similar ages, for the interval between the emergence of the first and last bird from a group of eggs incubated together was as great as 30 hours. As the eggs were collected before incubation had commenced and were then held at 40° F. for one to three weeks before being placed in the incubator, the actual developmental age of the first and last birds in such a hatch must differ widely, even though, one hour after emergence, both are considered to be "one hour old." Probably the temporal limits of the critical period for imprinting would be altered by an appropriatc adjustment of the post-hatching age. Therefore, it would seem wise in the future for researchers to report with more precision the exact ages of ducklings under study.

Results and Discussion

The general impression given by the 24-hour-old sheldrakes was that they were considerably less vocal than young Mallards, Redheads. and Wood Ducks. While these birds gcnerally replied to the introduced sound-signals by emitting pleasure or distrcss notes. the sheldrakes did so far less frequently, and they did not appear to chatter among themselves so much. The fear response shown by isolates of 24 hours of age when first handled was also pronouncedly less severe than in these other species. It should be rcmarked that all of the sheldrakes used in these cxpcrimcnts required assistance in breaking through

the shell—possibly because the relative humidity within the incubator was not sufficiently high to prevent toughening and adhesion of the shell membranes. However, those birds which did survive appeared to be normally vigorous, and this assistance probably did not affect their behavior appreciably. Similar help had been given some of the birds from the earlier experiments, and apparently they did not differ from their normally-hatched siblings.

Of 88 freshly collected eggs, 19 were infertile, 8 contained dead embryos before 25 days of incubation, 19 embryos died after 25 days, and 6 hatched with severe intestinal prolapses. The results of trials with 35 of the remaining birds may be seen in Table 1.

TABLE 1

SOUND-SIGNAL RESPONSES OF 35 COMMON SHELDRAKE DUCKLINGS

Training Group	No. of Ducklings	Proportion of Ducklings Responding to Sound-signals			
		Kom	**Hel-lo**	**Pip**	Total
Isolates	15	none	1/15	1/15	2/15
Sound Only	10	0/7		2/3[1]	2/10[1]
Following with Sound	10	1/6[1]		4/4[1]	5/10[1]

[1] Responded exclusively to sound to which they had been exposed.

It is more than moderately frustrating that the high mortality reduced the sample to a level where simple tests for significance cannot be applied. Certain comparisons with earlier data are possible, however. In the case of the Isolates among the Wood Ducks and Muscovy Ducks, 3/12 and 1/12, respectively, responded to one of the three sound signals (in addition to others), while among the surface-nesting ducks 12/12 responded. The confidence limits of these proportions do not overlap at the .05 level. Thus, it can be said that the sheldrakes, like the Cairinini studied, have no tendency to approach all rhythmic signals. The possibility that their responses are simply attuned to a narrower spectrum of sound, of course, cannot be eliminated, especially since so few test signals were used. But the difference from the surface-nesting birds remains.

Only 3/24 of the surface-nesters which had been members of the Sound Only group developed a specific response tendency directed exclusively toward the relevant signal, while the corresponding proportion for the Wood Ducks is 13/24. These proportions differ significantly at the .05 level. For the non-vocal Muscovy Ducks it is 0/18. The proportion for the sheldrakes is 2/10. In their seeming insusceptibility to auditory imprinting, the sheldrakes appear more like the other species than the Wood Duck.

Finally, in the Following with Sound group, 1/19 Muscovy Ducks, 1/24 Wood Ducks, but 16/25 surface-nesters developed a specific preference for the

relevant sound signal. Of the sheldrakes of this group 5/10 did the same, but it is striking that all five birds which were actually following the experimenter during the brief periods of exposure showed an extremely marked response to the relevant sound signals, and to these alone. Thus, while we cannot exclude the possibility that other sounds exist to which these birds would respond in the absence of visual and motor experience, it does appear that a preference can be established for sounds which are linked to a visual model. As in the surface-nesters, we may surmise that the following-response serves as a necessary reinforcement in the learning of particular sound-signals. This is decidedly not the pattern which was predicted for hole-nesting species, for whom auditory stimuli should be of greater importance than visual ones, and who should be either endowed with response tendencies directed to specific auditory stimuli at the time of hatching or else highly susceptible to auditory imprinting. This latter, for instance, seems to be true of the Wood Duck. We might thus suspect that newly hatched sheldrakes emerge from their burrows in response to visual or perhaps tactile stimuli, with auditory cues assuming a secondary importance.

Summary

Thirty-five incubator-hatched Common Sheldrake (*Tadorna tadorna*) ducklings were tested for determination of type and degree of auditory imprinting. Fifteen of them were isolated in a sound-proof room where they heard no extraneous sounds. These showed little tendency to approach repetitive sound-signals. In this respect they were similar to Wood Ducks (*Aix sponsa*), and Muscovy Ducks (*Cairina moschata*), and unlike many species of surface-nesting waterfowl. Ten others of the young ducklings were exposed intermittently to recorded sound-signals which produced no change in their response patterns and in this respect sheldrakes were unlike Wood Ducks. Ten others were allowed to follow the experimenter while being exposed to the sound-signals. A highly specific preference for the sound was evident. This behavior was characteristic of several species of surface-nesting waterfowl.

Literature Cited

Delacour, J., and E. Mayr
1945 The family Anatidae. *Wilson Bull.*, 57:1–55.

Klopfer, P.
1957 MS An analysis of learning in young Anatidae. (Ph.D. Thesis, Yale Univ., New Haven.)
1959 An analysis of learning in young Anatidae. *Ecology*, 40:90–101.

Thorpe, W. H., and R. A. Hinde
1956 An inexpensive type of sound-proof room suitable for zoological research. *Jour. Exper. Biol.*, 33:750–755.

Zoology Department, Duke University, Durham, N. C., July 23, 1958

SOME FUNCTIONS OF THE RECTRICES AND THEIR COVERTS IN THE LANDING OF PIGEONS

BY HARVEY I. FISHER

The tails of birds are used in many ways; at least, observational data have led to several postulated functions. This study is concerned with two of these—the tail as a supporting surface for part of the body weight, and the tail as an air-brake. Observations under field conditions have indicated to many workers, including the present one (1946:625), that the tail is frequently of major importance as a supporting surface and a balancing mechanism in flight. Further, depression of the tail just before the impact of landing indicates its probable use as a braking air-foil to slow forward motion.

Unfortunately, there has been no definite experimental evidence to support these hypotheses of function; and this information is virtually impossible to obtain under field conditions. Therefore, resort was taken to the experimental conditions used in previous studies (Fisher, 1956a, 1956b, 1957, 1958). Function of the tail in landing forms the basis of this study because the effects of experimental procedures can be measured.

Acknowledgments

I wish to express my appreciation to Dr. Lawrence Bartlett of the University of Massachusetts for his help with the initial experiments in the spring and summer of 1956. My thanks also go to the Graduate School of Southern Illinois University for its financial support of my continuing studies in the functional anatomy of birds.

Methods

Pigeons (*Columba livia*) were trained to fly through a cloth tunnel and to land on an apparatus capable of measuring the three vectors of force involved in landing.

The forces of landing were measured in groups of 100 landings made at weekly intervals. The control series (300 landings) was made first, and then successive series of 300 landings were made after each successive removal of feathers.

There were two patterns of removal of rectrices: 1) removal of the inner two rectrices on each side, followed by removal of the two next most medial ones, and finally elimination of all rectrices; and 2) removal of the two outermost rectrices on each side, followed by the two next outermost, and then all remaining tail feathers. As a last experimental act in each of the two procedures described, all tail coverts were taken off. In each instance the feathers were eliminated by clipping them next to the skin, using scissors. Replacement feathers were similarly eradicated in the few instances of their occurrence.

Thus, for each of the eight pigeons used (four for each of the two patterns of sequential removal of rectrices) there were 15 sets of data, obtained over a

period of 15 weeks, as follows: 300 control landings, 300 landings with four tail feathers off, 300 with eight rectrices removed, 300 with all tail feathers gone, and, finally, 300 landings of each bird with all rectrices and tail coverts removed.

The numerical data obtained were analyzed in several ways: 1) change during the 100 landings on any one day (Figs. 1 and 2); 2) change between consecutive weeks of the same series, that is, change within any one group such as the control landings; and 3) change between the different experimental and control series (Tables 1 and 2). In these analyses, comparison was made on the basis of averages of successive sets of 20 landings, of the 100 landings each week, of the first 100 landings after each experimental procedure, and averages of the 300 landings in each series.

TABLE 1

AVERAGE FORWARD (BRAKING) FORCES OF LANDING BEFORE AND AFTER REMOVAL OF TAIL FEATHERS[1]

	Removal progressive from inner to outer				Removal progressive from outer to inner			
Series	No. 106	107	109	111	No. 108	110	112	114
controls	13.2[2]	12.1	11.4	11.9	9.8	9.3	10.1	9.9
4 rectrices off	13.5	12.0	12.6	12.8	9.5	7.5	9.6	9.8
8 rectrices off	10.6	10.1	10.7	11.8	7.5	8.1	9.0	8.3
all rectrices off	11.5	11.5	10.4	11.0	8.3	7.5	8.5	8.6
tail coverts off	11.9	11.2	11.0	11.8	6.6	—	7.7	7.8

[1] Each average is of a total of 300 landings made on three successive weeks following feather removal.
[2] Forces are in millimeters of deflection. For conversion to grams see Fisher (1956b:338).

TABLE 2

AVERAGE DOWNWARD FORCES OF LANDING BEFORE AND AFTER REMOVAL OF TAIL FEATHERS[1]

	Removal progressive from inner to outer				Removal progressive from outer to inner			
Series	No. 106	107	109	111	No. 108	110	112	114
controls	10.6	10.9	10.7	11.0	9.4	9.3	9.9	8.9
4 rectrices off	11.9	12.0	12.6	12.1	9.6	7.5	9.7	9.0
8 rectrices off	10.3	10.5	12.0	11.5	9.4	8.1	8.6	9.3
all rectrices off	10.8	10.9	12.7	11.7	10.3	7.6	9.5	10.2
tail coverts off	11.8	12.3	12.0	12.2	10.1[2]	—	9.8	9.9

[1] See footnotes to Table 1.
[2] Only 240 landings; bird refused to land more than 40 times on first day.

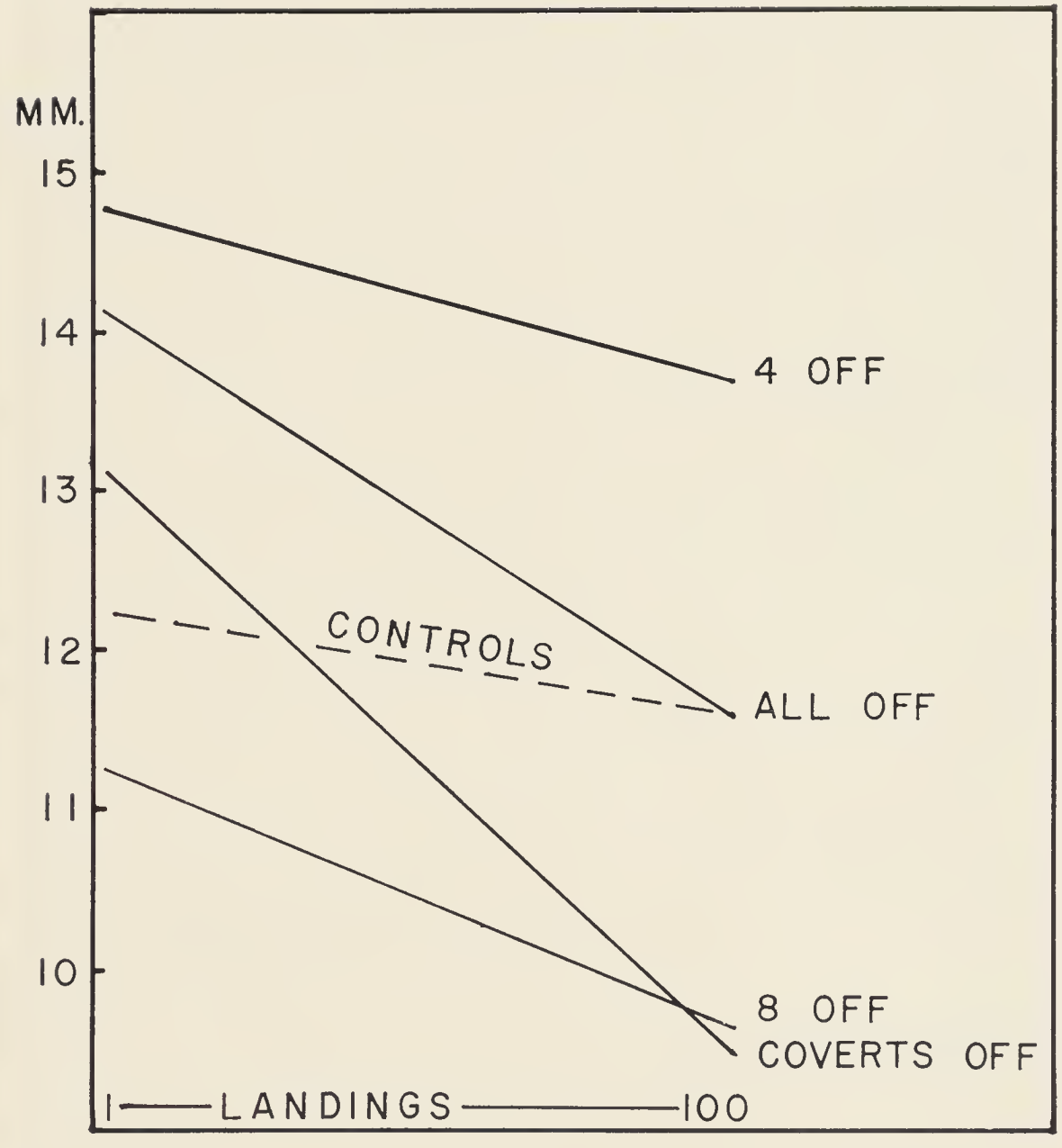

FIG. 1. Changes in braking force of landing of pigeon no. 107, with successive removal of tail feathers. Each line represents the averages of the first 20 and the last 20 landings on the first day of each series.

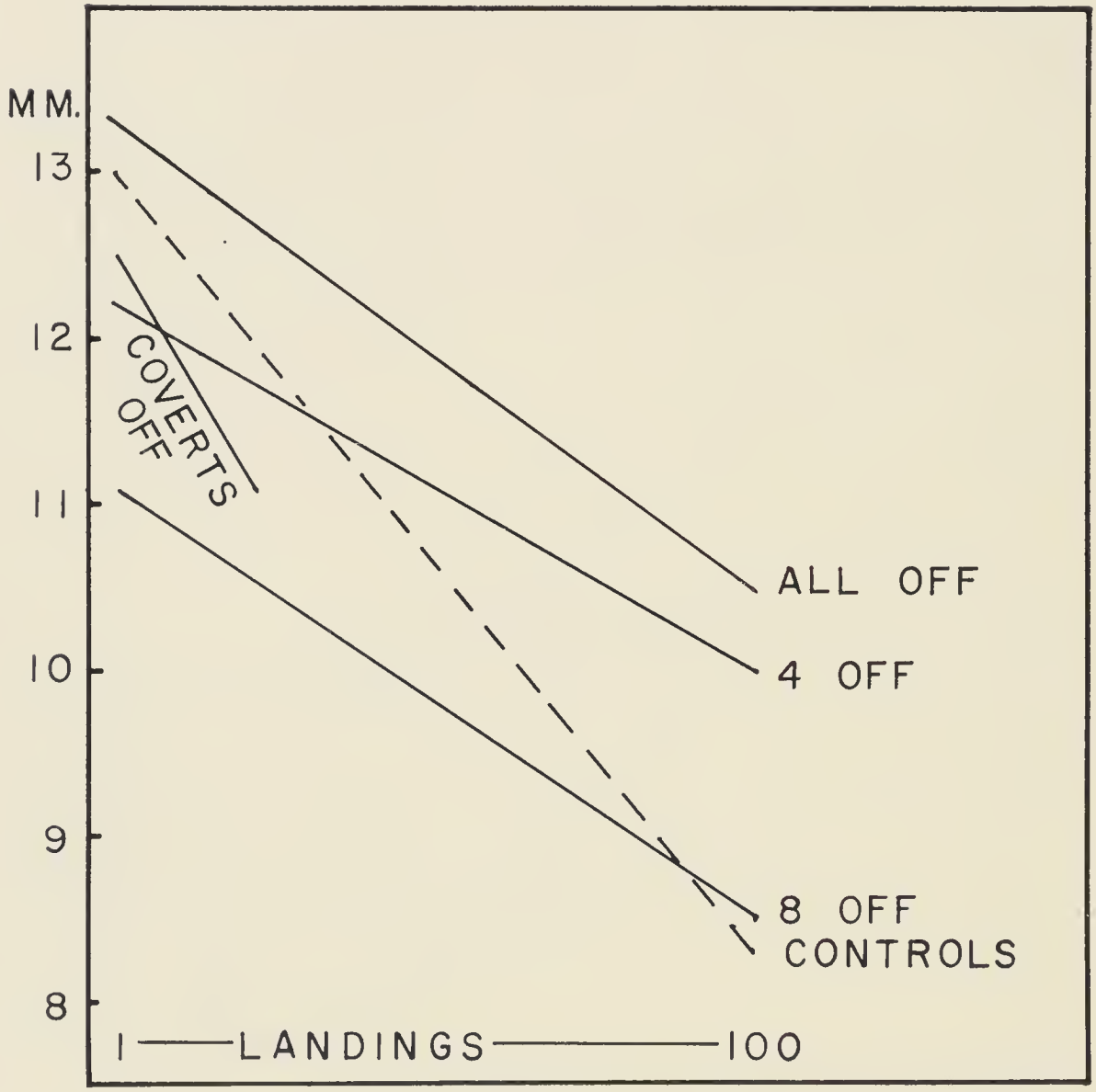

FIG. 2. Changes in downward force of landing of pigeon no. 108, with successive removal of tail feathers. Each line represents the averages of the first 20 and the last 20 landings on the first day of each series.

Results and Discussion

In most instances the various pigeons demonstrated the "learning to land" phenomenon postulated by Fisher (1956a). As before, this learning was observed within the 100 trials of each day (Figs. 1 and 2) and between consecutive weeks of each control and each experimental series.

In the analysis of successive trials it must be remembered, then, that a progressive decrease in forces would be expected. This decrease could be anticipated between the various experimental series. Thus, even in those instances where forces did not change, the very lack of change may be significant.

When feathers are removed from the center of an air-foil such as the tail, the surface area is not only decreased, it is broken into two foils. Each foil has turbulence along either edge and across its end; the increased turbulence reduces the effectiveness of the foil. Removal of feathers from either side of the tail reduces the area of the foil but probably does not materially affect the turbulence.

Under normal conditions the coverts probably do not directly affect either area or turbulence, but after removal of the rectrices the projecting coverts form an air-foil and affect both supporting area and amount of turbulence.

Successive removal of rectrices from medial to lateral.—Taking off the four central rectrices caused a major increase in both the braking and downward vectors, but the effect was greatest on the braking force (Tables 1 and 2, Figs. 1 and 2). Nevertheless, both forces decreased during the 300 trials, as the pigeons learned to land with their new tail-foil. Removal of four additional central rectrices did not interrupt this learning, and forces continued to decrease. However, when all the rectrices were taken away a new situation was presented, and the forces either increased or decreased only insignificantly. With expected learning, decreases should have occurred.

In these birds, removal of the coverts increased the initial forces of landing or at least prevented anticipated decreases (Tables 1 and 2), but, as exemplified by pigeon no. 107 (Fig. 1), the birds learned to land very lightly by the end of the first 100 trials after the coverts were clipped.

It was apparent in these four pigeons that the downward vector was affected more than the braking vector.

Successive removal of rectrices from lateral to medial.—This sequence of removal did not disrupt the previously established patterns of forces as much as removal from medial to lateral. This was expected.

Braking forces decreased at approximately the same rate as in previous experiments, except for the series of birds with four lateral rectrices off and with all rectrices off. These latter decreases were less.

Downward vectors of force exhibited no significant changes on the basis of averages (Table 2) and this indicated a loss of effectiveness in supporting

the body weight. It may be observed in Fig. 2 that the typical bird showed decreased downward forces during the first 100 trials after each removal. Nevertheless, all final trials had these forces as great or greater than the forces during the control landings.

Another phenomenon associated with removal of all rectrices and with removal of coverts was observed in three of the eight pigeons. Pigeon no. 106 was very hesitant to fly and land after covert-removal; many unsuccessful attempts were made. Pigeon no. 108 refused to fly and land more than 60 times immediately after covert removal; this same pigeon was "difficult" after all the rectrices were taken off. No. 110 never would perform properly after the coverts were eliminated. These three birds were well trained, and there had been no "reluctance" in prior landings. It is my feeling that these pigeons may not have performed because the tail was so ineffective.

In six pigeons Fisher (1956a: 95, Fig. 6) noted, during the first 100 trials, that downward force was greater in terms of millimeters of deflection than forward (braking) force and that the latter was more variable. In the four pigeons of this study in which removal of rectrices started medially, braking force exceeded down force in the first 600 landings and the two forces were approximately the same at the end of all experiments. In the four pigeons from which removal of lateral rectrices was first, the two forces were nearly equal initially, but downward force was much greater by the time the entire tail and coverts were removed, but only because braking forces decreased. The comparisons of the controls of this and the previous study indicate individual variation, of course, but the differences between the control series of 1956 and the present experimental ones are significant in their support of several opinions expressed above concerning the disruption, by the experimental procedure, of the decreases in forces that might be expected to result from learning. For example, only in the braking forces of pigeons subjected to removal of rectrices from lateral to medial is there consistency with the postulated pattern of decrease with learning.

Summary

Evidence is presented to show that the tail, in domestic pigeons, is used both as a mechanism for slowing forward motion (braking) just prior to landing and as part of the surface to support the weight of the bird.

Obviously the removal of rectrices, medially or laterally, reduces the supporting area; this would be expected to increase the downward vectors of force at the time of landing. However, the pigeon can compensate in some manner to hold these forces down to the control level. Removal of medial rectrices, because it forms two air-foils, with attendant increases in turbulence, where only one existed before, causes a greater increase in the downward vec-

tors. When the rectrices are removed in sequence from outermost to innermost, removal finally of the coverts causes no great increase; when the removal starts medially, taking off the coverts as a last procedure results in significant increases in downward vectors. In the latter instance the coverts form an important part of the functioning air-foil, replacing in part the absent medial rectrices.

The braking functions of the tail were less disturbed by removal of rectrices, probably because it is easier for the bird to compensate by varying its landing speed, its rate of wing-beat, and its angle of inclination at the moment of landing. Progressive removal from lateral to medial results in a pattern of braking forces not different from the patterns of decrease exhibited by control birds over comparable lengths of time. In other words, there is nearly complete compensation by the pigeons.

When medial rectrices are taken off first, the bird cannot compensate so completely for the effects of added turbulence and the decreased surface of the resulting double air-foil. In some pigeons little compensation, as indicated by little if any decrease in braking forces during the experiments, occurs. This breakup of the expected pattern of decrease reveals the use of the tail as an air-brake.

Literature Cited

Fisher, H. I.

1946 Adaptations and comparative anatomy of the locomotor apparatus of New World vultures. *Amer. Midl. Nat.*, 35:545–727.

1956a The landing forces of domestic pigeons. *Auk*, 73:85–105.

1956b Apparatus to measure forces involved in the landing and taking off of birds. *Amer. Midl. Nat.*, 55:334–342.

1957 Footedness in domestic pigeons. *Wilson Bull.*, 69:170–177.

1958 The function of M. depressor caudae and M. caudofemoralis in pigeons. *Auk*, 74:479–486.

Department of Zoology, Southern Illinois University, Carbondale, Illinois, February 16, 1958

GENERAL NOTES

Tarsal scutellation of song birds as a taxonomic character.—In arranging the shrikes (*Laniidae*) for a forthcoming volume of Peters' "Check-list," I found it necessary to evaluate the type of scutellation on the back of the tarsus as a taxonomic character. This quickly led beyond the shrikes and their near allies, to a hasty survey of the tarsal covering and its scutellation in all the oscine or song bird families.

Of necessity the dried feet of museum specimen skins were used, and distortion due to drying may have obscured certain points. However, some aspects of tarsal scutellation as an indicator of relationship did emerge.

The larks (*Alaudidae*) are distinctive in having a latiplantar tarsus. That is, the tarsus is rounded posteriorly and the covering of the front is separated from the scutellate covering of the back by a narrow groove on the inner side of the tarsus. This sets them off from the rest of the oscines and they are not considered further.

The tarsal envelope of the song birds, exclusive of the larks, is characterized by a single series of scutes, or a single plate, presumably of fused scutes (the booted condition) covering the front of the tarsus (the acrotarsium); a pair of plates, one on each side, covering the posterior or plantar part of the tarsus and being in contact with the acrotarsium in front, and meeting behind to form a ridge. This gives the diagnostic triangular cross section of the song-bird tarsus called acutiplantar.

There are modifications of this condition. The booted condition may not be complete, a few scutes being present at the distal end of the acrotarsium, or there may be obscure lines indicating nearly obliterated scutes along its length. On the plantar surface the "heel" and an area on the distal end of the tarsus are covered with skin that may be more or less rugose, papillose or even furnished with small scutes. These areas of skin may vary in extent and extend a short distance between the plantar plates and rarely may even meet, completely separating the plates.

A less common condition is for the outer surface of the plantar aspect of the tarsus to be scutellate. Sometimes these scutes are fairly regular. Sometimes they decrease in size distally and irregularly, and this condition is usually associated with lack of fusion between the elements. Then areas of skin, that may be rugose or papillose or carry small scutes, may be conspicuous between the inner plantar plate and the outer scutes, or even between the scutes. The least common condition is to have the inner plantar surface broken up into scutes. Despite the acutiplantar shape of the cross-section of the tarsus, the name taxaspidian might be applied to these plantar-scutellate tarsi, which are very similar to those in the non-oscine passerine family, Rhinocryptidae, of South America.

As one might expect, intermediate types occur, and also individual variation exists, making any finely divided and ironclad classification impractical.

However, the distribution among song bird groups of some clear-cut examples of each of the three main types, booted-laminiplantar, scutellate-laminiplantar, and scutellate-scutellate plantar, and the further modifications of the separation or fusion of the plantar scutes or plates, is illuminating.

The scutellate-laminiplantar condition predominates in most families of song birds, from cuckoo-shrikes (Campephagidae) to sparrows (Fringillidae) in Wetmore's arrangement.

The booted tarsus, always accompanied by the pair of plates on the plantar surface, predominates in the Turdidae (restricted sense), but also appears commonly in the related flycatchers (Muscicapidae, restricted sense). This booted condition also occurs occasionally elsewhere in widely separated groups, for example in Corvidae (*Pyrrhocorax*= *Coracia*), Timaliidae (*Orthonyx*), Sittidae (*Rhabdornis*), Meliphagidae (*Melipotes*), and

it is approached at least in some members of such groups as Paradiseidae, Cracticidae, Callaeidae, and Mimidae. Occasionally, perhaps as individual variation, the booted condition appears in Parulidae (*Peucedramus*, *Chamaethlypis*).

The scutellate outer plantar surface is a less common condition and characterizes no one group held together by other characters. Regular scutes on the outer plantar surface are present in some Laniidae (*Eurocephalus*, *Lanius* [part]), some Bombycillidae (*Hypocolius*, variable in *Ptilogonys*); and less regular scutes are present in some members of Corvidae (*Corvus*), Sturnidae (*Mino*, *Galeospar*), Oriolidae (*Sphecotheres*), Laniidae (*Lanioturdus*, *Nilaus*, *Prionops* [obscure, variable], *Tchagra* [part, variable]), and Ptilonorhynchidae (*Scenopoeetes*), and may be obscurely indicated in such diverse groups as Campephagidae (*Tephrodornis*) and Troglodytidae (*Salpinctes*), and occasionally as a single division of the plantar plate in many others.

The scutellate condition of the inner plantar surface does not always agree with that of the outer plantar surface, and seems equally variable. In the Laniidae, subfamily Prionopinae (helmet shrikes), the inner plantar scutellation is regular and compares well with that of the outer in *Eurocephalus*. However, in *Prionops*, in which the outer plantar scutellation is variable, that on the inner surface is still more so. In *P. retzii*, the only species in which I found inner plantar scutellation regularly, it occurred only about half the time. I did not find it in *P. plumata* (in which outer plantar scutellation is obscure, incomplete or absent), nor in the very similar *P. poliolopha* (outer surface obscurely to distinctly scutellate), nor the more different *P. caniceps* (outer surface not scutellate).

In the Malaconotinae (bush shrikes) *Nilaus* has the inner and outer plantar surfaces regularly scutellate; *Lanioturdus* (monotypic) may have them non-scutellate (i.e. laminar) or irregularly scutellate; in *Tchagra* I found no inner plantar scutellation though in some species, i.e., *T. cruentus*, the outer surface was regularly scutellate as an individual variant.

In Laniinae (typical shrikes) the outer plantar surface may or may not be scutellate, but I did not find it so on the inner.

A scutellate inner plantar surface also occurs in the Ploceidae, (weaver birds), in the genus *Bubalornis*.

The separated condition of the plantar plates or plates and scutes along the posterior mid-line occurs occasionally in such diverse groups as Laniidae (*Lanioturdus* [individual variation]), Vangidae (part: *Falculea*, distinct papillose skin, 1 specimen; *Leptopterus*, indistinct, 1 specimen), Sturnidae (part: *Mino*, distinct), Oriolidae (part: *Sphecotheres*, 2 lines of small scutes), Ptilonorhynchidae (part: *Scenopoeetes*, 2 lines of small scutes), Corvidae (part: *Corvus corax*, in which separation of plantar scutes from acrotarsium may be pronounced), and this condition is probably approached in many others.

Presumably a primitive condition of the song bird tarsus was to have the front of the tarsus scutellate and the back covered with numerous small scutella or granules (pycnaspidean condition) as seen today in some members of the family Cotingidae. From this the scutella on the back enlarged and coalesced into two plates and the frontal scutes coalesced, and the whole form a well fused, booted tarsal envelope, the most advanced condition.

On the other hand, part of the problem in deciding on relationships in the oscines is that there are really no primitive song birds. They are, so to speak, not twigs but leaves on the top of a postulated phylogenetic tree. So many other characters seem to appear and disappear sporadically (in shape of bill, color pattern, etc.) throughout the group that it comes as no surprise to find the same to be true of the types of tarsal scutellation.

That the condition of the tarsal scutellation is adaptive seems doubtful. We find the booted tarsus in semiterrestrial thrushes, arboreal honeyeaters of the twigs, and creepers of

the tree trunks. We find booted tarsi on slender-footed thrushes and a coarse-footed Timaliidae; on large choughs and small chats.

From the sporadic occurrence of various types of scutellation among song birds, and the individual variation they sometimes exhibit, the conclusion seems inescapable that the pattern of scutellation of the tarsal envelope is of limited importance as a character indicating relationships within the oscines, once the larks, Alaudidae, are excepted, nor will it separate oscines from nonoscines in all cases. The three main types of scutellation occur in one family (Corvidae). Even when a booted tarsus predominates in a family (as Turdidae, restricted sense), it does not separate its members from some of its near relatives (as the Muscicapidae), nor does its lack in other groups (as Sylviidae) preclude associating them with it (as in the family Muscicapidae in a comprehensive sense).

The well-defined scutellate plantar surface and the separation of the inner and outer plantar plates or scutes is a condition that occurs in obviously distantly related species. Individual variation in a species is such that the type of plantar scutellation may not even be a specific character.

One generalization that emerged from this survey was that the tarsal scutellation of the nine-primaried New World oscines is less variable than that of the Old World groups. Neither the extremes of the booted condition, nor of the scutellation of the plantar surface occurs in a well defined condition in the vireos to finches and their allies, which presumably had a common origin in the New World.

In regard to the shrikes, which started this survey, it is interesting that the least typical genera, whose relationships are most debatable, show the most distinct plantar scutellation (*Eurocephalus, Nilaus*), and the greatest variability (*Lanioturdus*, [monotypic, i.e. individual variation] and *Prionops* [individual and from species to species]). However, there is complete intergradation in this character with some more typical *Tchagra* and *Lanius*. Thus the presence or absence of tarsal scutellation in this group cannot be used, as was done in the past, to mark either family or subfamily limits.

Since the above was written an exceptional situation was found in some vireos of the genus *Hylophilus*. The tarsus of *H. ochraceiceps* is not acutiplantar but is latiplantar, with the back of the tarsus smoothly rounded, non-scutellate, and without a break at the midline. This is very different from the normal acutiplantar condition in *H. decurtatus* and in the rest of the oscines (except the larks), and recalls the condition in some tyrant flycatchers (Tyrannidae) and in the larks.

At first it seemed that the unusual condition in *H. ochraceiceps* might necessitate removal of the species from the oscines and allying it with the Tyrannidae, characterized by an exaspidean tarsus. However, *ochraceiceps* has a typical oscine aftershaft, and has the general structure, and appearance of a vireo. Though its habits seem little known, it seems that *ochraceiceps* is a vireo, as Ridgway (1904. *U. S. Nat. Mus. Bull.*, 50:214–218) considered it.

The difference between the details of the tarsus in *ochraceiceps* and in *decurtatus* raised the question as to whether a generic separation was advisable to call attention to this difference.

In *decurtatus* the acrotarsium is lightly scutellate and the two plantar plates meet behind at a sharp angle. In *ochraceiceps* the acrotarsium has the scutellation lightly indicated and the outer plantar plate is closely fused with the acrotarsium, and curves around the back of the tarsus, past the midline, to be separated from the inner edge of the acrotarsium by a groove, which is broad proximally, narrow or lacking distally (lined with the remnant of the inner plantar plate?).

However, the difference between these two conditions is bridged by that in certain other

species I have examined: *H. flavipes*, *H. thoracicus*, *H. poicilotis*, and *H. pectoralis*. It would seem that this latiplantar, quasi-exaspidean condition is best interpreted as a modification of the oscine acutiplantar condition. An attempt to divide *Hylophilus* into two genera would necessitate setting arbitrary limits and would be impractical.

In this case, an attempt to use tarsal scutellation as a "key character" for classification fails and recalls that Ridgway also had trouble (1907. *U. S. Nat. Mus. Bull.*, 50:336) when attempting to use the variations in the tarsal envelope for arranging the members of the Tyrannidae. He wrote, ". . . they have disappointed me . . . they seem of little value beyond the definition of genera (even sometimes failing here!) or minor supergeneric groups; indeed, it has been found that each of them is more or less variable within what appears to be proper generic limits."—A. L. Rand, *Chicago Natural History Museum, Chicago 5, Illinois, December 29, 1958.*

"Foot-paddling" feeding behavior in a Semi-palmated Sandpiper.—On August 5, 1958, I made the following observation on a mud flat in Newburyport Harbor, eastern Massachusetts. Together with several other species of shore birds, a number of Semi-palmated Sandpipers (*Ereunetes pusillus*) were feeding approximately 20 yards from my position on the edge of the flat. As the incoming tide slowly covered the mud, a number of small, shallow pools began to form, and the sandpipers were observed to probe in these pools as well as in the surrounding mud. I focussed my binoculars on one individual which had stopped momentarily to preen. Shortly afterward, this bird waded into a small pool about two feet in diameter, and began to "foot-paddle." With its body held horizontally, bill pointed down, the bird began alternately to lift and depress its legs very rapidly. The entire body of the bird moved rhythmically with the alternating motions of the feet and tarsi. The bird would paddle for about ten seconds, peer at the surface of the water for a moment, then stab rapidly. The movements of the bill were stabs, not probes in the mud. Three such stabs appeared to be successful in securing prey, since the bird made brief swallowing movements after each stab. The food secured by the use of "foot-paddling" was not identified. The entire behavior lasted three minutes, and it appeared to be terminated by the incoming tide flooding the temporary pool.

A cursory review of the literature revealed no mention of this behavior for the Semi-palmated Sandpiper, although similar feeding techniques have been observed in other species of sandpipers.—Andrew J. Meyerriecks, *Hatheway School of Conservation Education, Drumlin Farm, South Lincoln, Massachusetts, September 25, 1958.*

Tarsal oiling by a banded Fox Sparrow.—On April 2, 1958, I observed a Fox Sparrow (*Passerella iliaca*) anoint its tarsi after manipulating its uropygial gland. Similar behavior of a Lark Sparrow (*Chondestes grammacus*) has been described by Whitaker (1957. *Wilson Bull.*, 69:179–180), apparently the only other published report of this behavior. My observations were made at the Drumlin Farm Sanctuary near Lincoln, Massachusetts, where I was studying the morphology and sequence of maintenance activities of emberizines upon release from banding. This Fox Sparrow was banded with one aluminum band, inspected for fat and molt, measured, weighed, and released at about 12:45 p.m. Maintenance activities, such as preening and shaking, are given quite readily after banding, and it is assumed that handling and ruffling the feathers during the process accentuate exteroceptive stimuli which release these motions.

Oiling was performed three times, once on each leg after manipulation of the uropygial gland, and once on the unbanded leg after preening the breast. The actual oiling movements were not elaborate. Having just manipulated the preen gland, the Fox

Sparrow rubbed the side of its bill down the tarsus from the tarsal joint to the toes, where the motion ended. This was repeated on the other leg except that the motion ended at the band. Whether or not the band was partially responsible for stimulating the oiling motions cannot be ascertained, but several other Fox Sparrows banded the same day did not anoint the tarsi while preening. During the motion, the bird did not raise its leg from the limb, but instead bent its head down to oil the tarsi. The second occurrence, where only one leg was oiled, took place after the bird had preened down the breast, and the two motions nearly blended. This motion also stopped at the toes.

Mrs. Whitaker (*op. cit.*) described carefully the manner in which her captive Lark Sparrow performed these motions, and also reported that Mrs. A. Nelson has seen tarsal oiling by a captive House Sparrow (*Passer domesticus*). The behavior of my banded Fox Sparrow was similar to that of the Lark Sparrow in several respects: both birds rubbed the tarsi only while preening, both species performed bill wiping and shaking movements before but not during the oiling, and the sequence of motions after tarsal oiling ("usually starting by pulling at mid-breast feathers and then stropping remiges of either wing," Whitaker, *op. cit.*) was similar for both. There are, however, some differences. The Lark Sparrow thrust one foot forward in order to rub it, whereas my Fox Sparrow oiled the leg while still grasping the perch with both feet. Also, the Fox Sparrow did not oil its toes as the Lark Sparrow sometimes did. Certain relationships in sequence of movements in the Lark Sparrow did not hold true in the Fox Sparrow. For instance, the Lark Sparrow always bathed before oiling, which was not true of the Fox Sparrow, although a slight rain that was falling may have provided similar stimulus to the latter bird. Furthermore, tarsus oiling always came before breast preening in the Lark Sparrow, whereas the order of the two was variable in my Fox Sparrow. Finally, once preening of feathers began, the Lark Sparrow neither used the oil gland again nor rubbed the tarsus again, whereas the Fox Sparrow did both.

The significance of species differences in morphology and sequence of oiling and other maintenance activities cannot be evaluated from such short observations as these. Problems concerning the biological function of tarsal oiling and its possible connection with molt of tarsal scales are discussed by Whitaker (*op. cit.*) and nothing new can be added here. It is suggested that bird-banders who inspect their birds in the hand and watch them after release can contribute valuable information about this rare behavior trait.

I am indebted to Carl W. Helms for his help in the banding experiments, and to Dr. William H. Drury, Jr., Director of the Hatheway School of Conservation Education at Drumlin Farm for the use of a wire recorder and banding equipment which were used in the experiments.—Jack P. Hailman, *4401 Gladwyne Drive, Bethesda 14, Maryland, January 16, 1959.*

The taxonomy of the Robin in Mexico.—The taxonomic treatment accorded *Turdus migratorius* in the Mexican Check-List (Miller, *et al.*, 1957. *Pac. Coast Avifauna*, 33:1–436) was something of an innovation. However, no supporting data were presented. My own study generally confirms this arrangement and provides data. I studied 193 adult-plumaged Robins from Mexico, plus over 100 specimens of *T. m. propinquus* from western United States, and a few of each of the other races.

I acknowledge, with thanks, the courtesy of Dr. Robert T. Orr, at the California Academy of Sciences, and of Dr. Robert H. Storer at the University of Michigan Museum of Zoology. The curators of the University of California Museum of Vertebrate Zoology, the Chicago Natural History Museum, the University of Kansas Museum of Zool-

ogy, and the United States National Museum courteously loaned me their Mexican Robins.

The chief size difference which has been claimed as differing geographically is wing length. The data in Table 1 suggest that even this is a poor character. There is a weakly-marked cline of wing length, decreasing from the southern Rocky Mountains southward through northwestern Mexico to the Transvolcanic Range in Jalisco, thence eastward, and culminating southward in Guerrero in the smallest population.

Table 1
Wing Length (in mm.) of Adult Male Robins

Race	Locality	Size of Sample	Range	Mean	Standard Deviation	Coefficient of Variability
propinquus	California and Nevada	25	130–139	135.0	2.74	2.03
"	Southern Arizona and Northern Sonora	11	132–139	136.9	1.75	1.28
"	Northeastern New Mexico and western Texas	12	134–144	138.1	3.27	2.37
"	Northwestern Chihuahua	10	137–145	140.2	2.12	1.51
"	Southwestern Chihuahua, Durango, and western Zacatecas	11	132–144	135.5	3.77	2.78
phillipsi	Jalisco and Michoacán	16	129–141	134.9	3.36	2.49
"	Nuevo Leon, Morelos, Oaxaca, and state of Mexico	5	129–139	134.4	—	—
"	Guerrero	41	130–138	133.9	2.45	1.86

Color shows a definite cline of increasing dorsal darkness and ventral brightness, from southwestern United States southeastward to southern Mexico. The most definite step in the material studied occurred at the Zacatecas–Jalisco border.

Sexual dimorphism in color is rather prominent in the Robin, but males from one population are sometimes similar to females from another population. Fall specimens in fresh plumage were the basis for the statements on color made herein; however, carefully sexed adults in worn plumage could be identified.

The two races breeding in Mexico are:

Turdus migratorius propinquus Ridgway

Turdus propinquus R. Ridgway, *Bull. Nuttall Orn. Club*, 2:9, 1877 (Laramie Peak, Wyoming).

Lacking the white tail corners of *migratorius*, *achrusterus*, and *nigrideus*: paler throughout and less reddish ventrally than *caurinus*; as compared with *phillipsi*, paler dorsally, less bright-ochraceous and either redder or duller ventrally, averaging less blackish on the throat, and with more white flecks ventrally.

There is considerable variation within the range of *propinquus*. The populations of the southern Rocky Mountains and northwestern Mexico are grayer, less brownish dorsally than those of California, Oregon, and Nevada; as well as paler, less reddish, ventrally. Certain specimens from the southern Sierra Madre Occidental, in Zacatecas and southern Durango, approach *phillipsi* in brightness of the ventral ochraceous.

Range: (based on specimens examined) Breeding in western United States, and mountains of northwestern Mexico south to southern Durango and western Zacatecas. South in winter as far as Guerrero and state of Mexico.

Turdus migratorius phillipsi Bangs

Turdus migratorius phillipsi O. Bangs, *Proc. Biol. Soc. Wash.*, 37:125, 1915 (Las Vigas, Vera Cruz).

Similar to *propinquus*, but darker and often browner dorsally; a brighter hue of ochraceous and often less reddish ventrally; averaging blacker on the throat; and with fewer white flecks ventrally. As compared with *caurinus*, more ochraceous, less ruddy ventrally.

The population of Jalisco and Michoacán approaches *propinquus* in that it averages paler dorsally and duller ventrally than that of eastern Mexico and Guerrero. A few of the specimens from eastern Mexico (Hidalgo, Vera Cruz, etc.) are perhaps slightly ruddier, less ochraceous ventrally than any comparable ones from southwestern Mexico (Guerrero), but the tendency is difficult to discern and in my opinion does not even approach the order of a subspecific distinction. In other words, I regard *T. m. permixtus* Griscom as a synonym of *phillipsi*.

Range: (based on specimens examined) Resident from Jalisco, Michoacán, and Nuevo Leon south to Guerrero and Oaxaca.

Mexican Specimens Examined.—Sixteen specimens are unidentifiable to race because of lack of sexing, or questionable sexing, in conjunction with worn plumage. Spotted juveniles are not included. Migrant and wintering specimens are included.

T. m. migratorius—Yucatán 1, Vera Cruz 1, Nuevo Leon 2.

T. m. propinquus—Guerrero 6, Michoacán 1, state of Mexico 1, Guanajuato 1, Zacatecas 14, Durango 6, Chihuahua 13, Sonora 4.

T. m. phillipsi—Jalisco 17, Michoacán 11, Nuevo Leon 1, state of Mexico 3, Hidalgo 1, Federal District 1, Puebla 1, Vera Cruz 2, Oaxaca 1, Guerrero 76.

J. Dan Webster, *Hanover College, Hanover, Indiana*, and *California Academy of Sciences, San Francisco, February 27, 1959.*

Octaves and kilocycles in bird songs.—In recent years physicists have discovered a means of recording sounds in visible marks. This is by machines such as the audiospectrograph (Kellogg and Stein, 1953) and the vibralyzer (Borror and Reese, 1953). The markings produced in this way are similar to those that I have made representing sounds heard by ear, in that time is represented horizontally and pitch vertically. There are other differences, however, that need explanation so that we may understand both kinds of records.

In the mechanical records pitch is measured in kilocycles. When I first studied the physics of sound the term used was vibration. Brand (1935) used the term frequency. Although technically different terms, cycle, vibration, and frequency have been used by different authors to represent the same attribute of bird song.

In the methods I have used in recording bird songs the pitch is measured in octaves. The octave differs from the kilocycle in that each octave contains twice as many cycles as the previous one (or half as many as the following one). To put it mathematically, in the kilocycle the cycles increase in an arithmetical progression, but in the octave in a geometrical progression. Therefore, the first kilocycle, from 0 to 1000 cycles, begins below the limit of man's hearing and contains all of the octaves up to just below C_5, as Brand (1935) designates it. This is C″ in the method I (1951) used in the Guide to Bird Songs. C″ contains 1024 cycles. The next kilocycle is almost coincident with the next octave, which extends from 1024 to 2048 cycles. After that, the two octaves from C‴ to C⁗, the place where the songs of most of small bird singers are pitched, contains no less than six kilocycles.

A division of the octave is a tone. We cannot say just how many cycles a tone contains because that depends on just where it is in the musical scale. For example, the difference in pitch of the two notes in the "phoebe" whistle of the Black-capped Chickadee (*Parus atricapillus*) is not always on the same pitch, for an individual bird may sing it from B to A, and then change and sing it from A to G. I do not mean to imply that the pitch of the bird note is exactly what musicians refer to as concert pitch, but I do mean that if the bird's A is a few cycles off concert pitch, its G is also off enough to make the interval a perfect tone.

A great many of our bird songs contain intervals based on tones and their multiples: thirds, fourths, fifths, and octaves. The most common form of the song of the White-throated Sparrow (*Zonotrichia albicollis*), for example, has a perfect fourth between the first and second notes (Saunders, 1951:269, Fig. 159, No. 1). It is as if the bird sang its *Old Sam* on the notes "sol do." In the song of the Ruby-crowned Kinglet (*Regulus calendula*) the interval between the first and second parts is frequently, but not always, an exact octave (Saunders, 1951:153, Fig. 80). Natural music of both man and birds has been that way since long before man invented our present system of writing music. Chords and harmonies are recognized without realization of what it is that makes them such. Some people may not appreciate this due to a lack of musical "ear." Others, who are naturally musical, but not trained to know just what it means, may appreciate such things. When a group of men and women sing together some familiar air, the men actually sing one octave lower than the women without realizing it. They could not possibly sing one kilocycle lower. Those who have no musical "ear" should not attempt to describe bird songs, nor to criticize those who do so, any more than a color-blind person should attempt to describe birds' plumages.

The mechanical method of recording, because it relies on kilocycles, rather than octaves, seems to hide the music in bird songs. On the other hand it does show things that recording by ear cannot. In the study of the Wood Thrush (*Hylocichla mustelina*) songs (Borror and Reese, 1956), it shows that the bird can sing three notes at the same time. This is a matter that I once noted in a Cardinal (*Richmondena cardinalis*) when a bird sang two distinct songs at once, and I could hardly believe my ears (Saunders, 1923), so I am glad to have my experience corroborated.

In the matter of time, especially in very short notes or songs, the mechanical recordings are much more accurate than the stop-watch. The shortest time registered by a stop-watch is ⅕ of a second. Very short songs such as that of Henslow's Sparrow (*Passerherbulus henslowii*), or a single *chebec* of the Least Flycatcher (*Empidonax minimus*) cannot be timed shorter than this with a stop-watch, but the mechanical recordings show that the songs can be much shorter (Borror and Reese, 1954), and that in the Henslow's Sparrow a song that sounds like two notes may be as many as five.

Bird songs are characters of living birds that have just as much to do with distinctions between species as do the characters that are retained in bird skins. The audio-spectrograph has shown that two different kinds of Traill's Flycatcher (*Empidonax traillii*) occur in central New York, and photography shows that they build distinctly different nests (Kellogg and Stein, 1953). This would seem to be good evidence that they are different forms, but the taxonomists have not indicated at what taxonomic level.

Literature Cited

Borror, D. J., and C. R. Reese

1953 The analysis of bird songs by means of a vibralyzer. *Wilson Bull.*, 65:271–276.

1954 Analytical studies of Henslow's Sparrow songs. *Wilson Bull.*, 66:243–252.

1956 Vocal gymnastics in Wood Thrush songs. *Ohio Jour. Sci.*, 56:177–182.

Brand, A. R.
1935 A method for the intensive study of bird songs. *Auk*, 52:40–53.
Kellogg, P. P., and R. C. Stein
1953 Audio-spectrographic analysis of the songs of the Alder Flycatcher. *Wilson Bull.*, 65:75–80.
Saunders, A. A.
1923 A double song of the Cardinal. *Auk*, 40:539–541.
1951 A guide to bird songs. (2nd ed.) Doubleday and Co., New York. 307 pp.

Aretas A. Saunders, *P. O. Box 141, Canaan, Connecticut, May 8, 1959.*

Early and elaborate nests of the Killdeer in Hancock County, Ohio.—The beginning of the nesting season for the Killdeer (*Charadrius vociferus*) in Ohio is usually given as "April," although it sometimes begins in March. On March 31, 1946, I found a Killdeer nest containing four eggs in front of the clubhouse of the Skeet Club, two miles southeast of Findlay, Ohio. On March 24, 1945, I found a nest containing three eggs in a stone quarry in Findlay. A fourth egg was laid on March 26.

The Killdeer may build a nest more often than is popularly supposed. Of 10 nests found in recent years, two have been elaborately constructed. One of these was found between two rows of plants in a soybean field on June 30, 1948. It contained four eggs. This nest was built in a slight depression, the bottom of which was paved with small pebbles. These stones were flat and about half an inch wide.

The other elaborately constructed nest was the March 24 nest mentioned above. This nest was four inches in diameter, placed in a slight depression, and surrounded by a rough circle of eight pieces of limestone, averaging two inches in height. The area between these rocks had been paved with approximately 180 flat pieces of limestone and coal. The paving material toward the center of the nest averaged one-fourth inch in diameter. The outer edge of the nest was higher than the center and consisted of larger pieces of stone and coal averaging one-half inch in diameter. The four eggs in this nest hatched before 9:00 a.m. on April 19.—Richard Stuart Phillips, *834 Liberty Street, Findlay, Ohio, February 11, 1959.*

A hybrid White-crowned × White-throated Sparrow.—On several occasions at Fort Belvoir, Fairfax County, Virginia, in December, 1957, and January, 1958, several people, including P. A. DuMont, Donald Lamm, and I, had excellent views of what were thought to be at least three adult Gambel's Sparrows (*Zonotrichia leucophrys gambelii*). The birds were in a mixed flock of sparrows, including nine or 10 White-crowned Sparrows (*Z. l. leucophrys*). I collected one of the three supposedly Gambel's Sparrows on January 5, 1958, at Fort Belvoir. The specimen was prepared as no. 468554 (U. S. National Museum).

The specimen was not prepared until mid-May but was then compared carefully to specimens of the genus *Zonotrichia* in the USNM. In the opinions of Dr. Alexander Wetmore, Dr. John Aldrich, Dr. H. Friedmann, and Mr. H. G. Diegnan, specimen no. 468554 is a hybrid between White-crowned and White-throated (*Z. albicollis*) Sparrows, and not an example of Gambel's Sparrow.

The two most convincing characteristics which led to this conclusion are: (1) The very broad and large white loral area corresponding exactly in size and shape with that area in *Z. albicollis* (which is yellow in adults of that species). This same area in every specimen of *Z. l. gambelii* at the USNM is much narrower and more confined. (2) The coloration

of the feathers at the bend of the wing in specimen no. 468554, and in all those of *Z. albicollis* in the USNM are lemon yellow, whereas this same area is cream or white in specimens of *Z. l. leucophrys* and *Z. l. gambelii*.

Several other pertinent features of the hybrid specimen are: (1) Extreme amount of chestnut in the edgings of the secondary wing feather corresponding well with the majority of specimens of *Z. albicollis*, whereas in specimens of *Z. l. leucophrys* and *Z. l. gambelii*, this color, if present, is either confined to a much narrower area on each feather and to a less extensive area on the wing, or is darker (almost umber) in color. (2) The nearly pure white belly and pure gray breast of the specimen which match the normal shades of *Z. albicollis* rather than the darker gray and/or brownish-tinted coloring of these areas in nearly all specimens of *Z. l. leucophrys* and *Z. l. gambelii*.

This appears to be the first known specimen of a hybrid between *Z. l. leucophrys* and *Z. albicollis*. Cockrum (1952. *Wilson Bull.*, 64:150) reported no record of such a hybrid. A search of the literature since that date has revealed no notation of previous examples of such a hybrid as this one.—Jackson M. Abbott, *1100 Doter Drive, Alexandria, Virginia, January 12, 1959.*

A nesting colony of Forster's Terns and Black Skimmers in Southwestern Louisiana.—From July 12 to August 18, 1958, a small breeding colony of Forster's Terns (*Sterna forsteri*) and Black Skimmers (*Rynchops nigra*) was observed on Rockefeller Refuge in southwestern Louisiana. The refuge is an expanse of marshland adjacent to the Gulf of Mexico. The nesting birds were concentrated on two low clay levees on the margin of Deep Lake, approximately four miles inland from the coast. The levees were parallel and separated by a canal 150 yards wide. Each levee was about five yards wide by 400 yards long, and the maximum height of either area was 18 inches above water level. Waves frequently washed across the levees in several locations. Nesting was concentrated at the ends of the levees. The vegetation was very sparse and consisted of scattered clumps of *Spartina alterniflora*, *Distichlis spicata*, and *Heliotropium curassavicum*.

The average population of the colony was 165 Black Skimmers (range 118 to 207) and 53 Forster's Terns (range 46 to 57). Actual nest concentration of the two species, however, was about equal. Maximum nest counts, on nine checking dates, were 76 Black Skimmer nests and 62 Forster's Tern nests. There were nearly three times as many skimmers as there were skimmer nests, but there was approximately one tern for each tern nest. This suggests that the Black Skimmer population was composed of breeding and non-breeding birds of both sexes. The Forster's Tern population, however, probably consisted of nesting birds of only one sex.

Terns and skimmers nested close together on both levees, but the ratio of the nesting species in the two locations was quite different. On the north levee the ratio of Forster's Tern nests to Black Skimmer nests was 4:1. The ratio was just the reverse on the south levee. There was no apparent conflict between species.

The Black Skimmer nests were merely depressions in the hard clay. The tern nests were prominent conical mounds of dead marsh vegetation, each containing a definite depression on top. The number of eggs per nest was about three for both species. Many skimmer eggs, particularly on the south levee, were concentrated at the water edge. They had either been laid at random, thrown from the nest, or washed from the levee by high waves.

The height of nesting occurred in the tern population on July 12, but the Black Skimmer population did not attain a nesting peak until July 25. Downy young terns

were first observed on July 14, and Black Skimmer young were not seen until July 30. Nesting was completed for the terns by the first week of August, but the majority of the skimmer eggs had not hatched until August 18.

Egg-laying dates of this particular colony are unusually late. Probably this represents at least a second nesting effort of both species. Low, exposed levees projecting into open expanses of water would be precarious sites, quite vulnerable to inundation.—J. L. Chamberlain, *Department of Biology, Randolph–Macon Woman's College, Lynchburg, Virginia, February 22, 1959.*

NEW LIFE MEMBER

Donald N. Bucknell, of Ingersoll, Ontario, is joining the growing number of Life Members of the Wilson Ornithological Society. His interest in ornithological natural history is an avocation from his exacting duties as a time-study- and standards-analyst for a manufacturing firm. Mr. Bucknell is a past-president of the Ingersoll Nature Club, and is also a member of the A. O. U. and the Federation of Ontario Naturalists. He also spends considerable time and energy as Scout Leader of a troop of 36 boys, instructing them in his special interests in birds and plants.

ORNITHOLOGICAL NEWS

We are happy to announce that Betty Carnes has become the third Patron of The Wilson Ornithological Society.

Louis Agassiz Fuertes Research Grant

Although it was not possible to make a grant this past year, the Research Grant Committee hopes to make an award for 1960. Application forms may be obtained from the Chairman, Harvey I. Fisher, Southern Illinois University, Carbondale, Illinois. Completed applications must be received by March 1, 1960.

The Committee wishes to emphasize that any type of ornithological research may be supported and that recipients need not be affiliated with educational institutions. In fact, the Committee hopes to encourage the development of research by amateur ornithologists. The important criterion in awarding funds will be the contribution to knowledge intrinsic to the work envisioned. It will be easier for the reviewers to judge the potential of a problem if work is already in progress. Consequently, applicants should prepare careful outlines of their projects and include information already obtained.

The Committee trusts that those interested in ornithology will encourage donations to the research fund and will stimulate qualified persons to apply for grants. It is felt that the amateur ornithologists of the United States constitute a virtually untapped source of research effort. We can increase ornithological knowledge a great deal by proper inspiration of and help for these workers.

Request for Information

As part of a study of the shorebird population on the Florida Gulf coast, a large number of Short-billed Dowitchers, Semipalmated Plovers, Dunlins, and lesser numbers of other waders were trapped, banded and color-dyed in the spring, 1959. Birds caught in May were dyed a vivid golden color which is known to have remained unaltered after at least one month on a dowitcher. Birds trapped in June were dyed scarlet, though dyed birds seen two weeks later were only pinkish in hue. All birds dyed were presumed to be in northward migration. Other colors will be used in the fall, 1959.

It is earnestly requested that anyone observing such colored shorebirds please communicate promptly with me, stating color, species, and date and location of observation. —*Horace Loftin, Department of Biological Sciences, Florida State University, Tallahassee, Florida.*

ORNITHOLOGICAL LITERATURE

THE BIRDS OF THE PALEARCTIC FAUNA. Passeriformes. By Charles Vaurie. H. F. & G. Witherby, London, 1959: 10¼ × 7¼ in., xii + 762 pp. $16.00.

There are two principal ways of going about the preparation of a check-list for any major geographic area. It may be done by a committee, usually composed of members appointed by the pertinent scientific organization, sometimes of individuals with a common interest in the region in question. Among bird lists, these two variations of the first approach are exemplified by the A.O.U. and B.O.U. Check-lists, and the "Check-list of the Birds of Mexico," respectively. The second method is that of single authorship, in which one man takes on the job, soliciting help and advice from his colleagues as required, but unhampered by any committee structure. Examples of this approach include the well-known works on Africa by Sclater, Australasia by Mathews, the West Indies by Bond, Colombia by de Schauensee, the first seven volumes of the Peters "Check-list of Birds of the World," and numerous others.

The publication of the first volume of Dr. Vaurie's important work on Palearctic birds helps to confirm the opinion, held by many, that the single-author approach is the preferable method of producing a major check-list. Speed of publication is one important factor; the first paper in Vaurie's preliminary series of "Systematic Notes" appeared in December, 1953, and he was reading page-proofs of the present volume less than five years later. This contrasts with the 18 years that elapsed between the formation of a committee to prepare a fifth edition of the A.O.U. Check-list and the actual publication of that volume. It is acknowledged that the comparison is not wholly a fair one; the 18-year span included the period of World War II, and throughout the entire time most of the committee members could devote only a relatively small proportion of their working hours to the Check-list. It is true, too, that Vaurie's volume includes only the Passeriformes, but the scope of the information included in his check-list substantially exceeds that in the A.O.U. list. These statements must not be construed as criticisms of the individual members of the A.O.U. Check-list Committee, nor as a suggestion that a single author prepare the sixth edition of the A.O.U. list. The comparison is made primarily to indicate the magnitude of the task Vaurie has accomplished (he is well underway in the writing of the second volume).

The somewhat pedantic title of Vaurie's work was undoubtedly chosen to acknowledge its relationship to Hartert's classical "Die Vögel der Paläarktischen Fauna" (1903–1922). Vaurie has chosen, quite rightly, not to duplicate much of the substance of Hartert's work (keys, detailed descriptions, complete synonymies) in the new book. On the other hand, information presented for each species far exceeds that in most check-lists. Post-Hartert synonymies, together with references to major revisions and monographs, are given, but detailed systematic discussions (frequent in Hartert) were published separately in Vaurie's preliminary series of 33 "Systematic Notes on Palearctic Birds"; the working systematist should have this series bound as a companion volume to the check-list itself.

The geographic range is given for both the species as a whole and for each subspecies, as in the A.O.U. Check-list; there is also a list of extra-limital subspecies. A useful addition to the statement of species range is a brief description of preferred habitat. English vernacular names are supplied for all species, and French and German names for species occurring in countries using those languages. Since all of these are separately indexed, there are thus *four* indices: for English, French, German, and scientific names.

One of the chief characteristics of the single-author check-list, as opposed to the committee or A.O.U. type, is its uniformity of viewpoint. The responsibility for all taxonomic

decisions is the author's, unless otherwise stated. This fact can be helpful to later workers who may wish to discuss or dispute a point with the author; in the case of the A.O.U. Check-list, it is virtually impossible to determine how and by whom any given taxonomic decision was made. The uniformity of viewpoint of the single-author check-list *can* be something of a shortcoming if the author happens to be an extremist of either the "lumping" or the "splitting" schools. In lists published by lumpers, the reader usually has no way of knowing whether subspecific names have been synonymized by the author on objective (i.e., nomenclatorial) or subjective (i.e., taxonomic) grounds. Vaurie, who tends to be somewhat of a lumper at the subspecies level, has overcome this difficulty in an ingenious way. First, for many polytypic species he has included a general paragraph on geographical variation, pointing out the nature of the important trends of variation within the species as a whole. Each subspecies which is considered to be well differentiated takes its place in the list without further comment. Moderately-well differentiated subspecies also have regular positions on the list, but are prefixed by the symbol (o). In the synonymies, those names regarded as absolute synonyms appear without comment, while those names which have been given to populations considered by Vaurie to be insufficiently differentiated to be worthy of nomenclatorial recognition are prefixed with an asterisk, and a comment on their status (usually stages on a cline) often appended. This system will undoubtedly represent a genuinely helpful tool to workers who may wish to re-evaluate Vaurie's treatment of a given species.

I do not propose to comment on Vaurie's taxonomic treatment of any particular group of birds. No specialist will read this (or any other) check-list without finding some occasion to differ with the author. My own studies, for instance, have led me to conclusions differing from Vaurie's in (among others) *Hirundo daurica* and *Passer montanus*. Such differences of opinion are inevitable among taxonomists, and certainly do not affect the usefulness and importance of Vaurie's book.

One of the major contributions of the present check-list lies in its detailed and up-to-date treatment of the distribution of the birds of the eastern portion of the Palearctic region, an area whose very geography (much less its avifauna) is unknown to most westerners. Vaurie has had the benefit of extensive correspondence with Russian ornithologists, and has been able to avail himself of literature and specimens seen by few, if any, other western workers. An excellent gazetteer and two sketch maps (Turkestan and western China) are invaluable aids to the understanding of Asian distribution patterns. Even more maps would have been a great convenience, but the latitudes and longitudes given in the gazetteer will enable the reader to locate most places on National Geographic or other readily available maps.

In view of the substantial number of species appearing on both lists, differences between the treatment of the A.O.U. Check-list and that of Vaurie's book will be of interest to American readers. These differences are relatively few, and concern mostly species accidental in North America (the non-passerine volume will naturally include a much larger number of holarctic species). Among the birds other than these accidentals, the following departures from A.O.U. usage were noted:

Petrochelidon is reduced to a subgenus of *Hirundo*; *Anthus spinoletta pacificus* Todd is mentioned in a footnote, but *A. s. alticola* is omitted; *Lanius excubitor invictus* may not be separable from *L. e. sibiricus*; *Corvus corax clarionensis* is omitted from the list of extralimital races of the species; the Bohemian Waxwing is *Bombycilla garrulus*, not *B. garrula*; the subfamily Regulinae is not recognized as separate from the Sylviinae; the latter group and the Turdinae are considered subfamilies of the Muscicapidae; *Catharus* is used for the three species of "*Hylocichla*" known from the Palearctic; the Aegithalidae and Remizidae are given full family rank (the former would include the Bush-tits and the

latter the Verdin) ; the Sittinae are treated as a subfamily of the Paridae; *Spinus* (but not *Acanthis*!) is considered a synonym of *Carduelis*; *Acanthis flammea holboelli* is not recognized (considered a doubtful race in the A.O.U. Check-list) ; the North American rosy finches are considered races of the Old World *Leucosticte arctoa*; and the Emberizidae are given full family rank.

The volume itself is an outstandingly attractive piece of book-making. The typography is particularly handsome, and a light-weight but strong and opaque paper permits this book of almost 800 pages to be handled easily. The binding is perhaps a little flimsy for the amount of use to which many people will put the book, but that has been a shortcoming of many products of English publishers in recent years. The text is remarkably free from typographical errors. There is one *lapsus calami*: on pp. 541 and 542, the species name *familiaris* was inadvertently substituted for *brachydactyla* in the discussion of geographic variation in the Short-toed Tree Creeper.

Dr. Vaurie has made a major contribution to the basic literature of ornithology, and many of us will await with impatience the publication of the second volume.—Kenneth C. Parkes.

The Waterfowl of the World. By Jean Delacour. Volume Two. The Dabbling Ducks. Country Life Limited, London, 1956: 8 × 10 in., 232 pp., 29 maps and 24 color plates by Peter Scott.

This second volume of Jean Delacour's series continues the attractive and somewhat sumptuous format established by the first, with wide margins, good paper, numerous maps and a generous 24 full-color plates. It covers the dabbling ducks or tribe Anatini and follows, in general, the classification proposed by Delacour and Ernst Mayr in *The Wilson Bulletin* for 1945.

The genus *Anas* is broadly interpreted, including 38 species and 74 retained subspecies, or essentially all the familiar dabbling ducks and their related species in other hemispheres, plus Salvadori's Duck (*A. waigiuensis*) of New Guinea and the Ringed Teal (*A. leucophrys*) of South America.

In addition, five monospecific genera of doubtful position, or those showing relationship to both dabbling and diving ducks, are included. These are: *Rhodonessa*, the Pink-headed Duck of India; *Malacorhynchus*, the Australian Pink-eared Duck; *Hymenolaimus*, the Mountain Blue Duck of New Zealand; *Stictonetta*, the Freckled Duck of Australia; and *Merganetta*, the Torrent Ducks of South America. This last genus is included on the basis of Niethammer's anatomical studies (1952. *Jour. f. Ornith.*, 93:357–360).

It is indeed fortunate that the author is a "lumper" who sees relationships as more interesting than differences. He may thus save a generation of us interested in waterfowl from the confusion of the "splitters."

It is wonderful to find within the same covers all the most pertinent information on this popular group of birds—not only color plates and distribution maps of every species and subspecies, but significant taxonomic features, basic synonymy, incubation periods, behavior observations, and a very thorough summary of the history of each in captivity. In addition to the essences of the widely scattered literature which Delacour has distilled for us, there is a great deal of new observation drawn from the author's wide experience and from unpublished studies still being pursued by others, such as those of Harry Frith on the Pink-eared and the Freckled Ducks in Australia.

The color plates again show the great artistic skill of Peter Scott. It is his eye for design that permits 12 to 14 ducks to be shown on one plate. Although all are oriented alike to

facilitate comparisons, an interesting posture or displacement preen is deftly used to make more room and to prevent any feeling of crowding. Excellent color reproduction has preserved every detail, down to the highlight in the delicate translucent pink eye of the Cape Teal (Plate XV, p. 142). Differences in leg color due to age, sex or season seem to have been ignored in some species, such as the Shovelers, and, although mentioned in the text for the American Black Duck, have been lost on the plate. (For color documentation of these differences see Shortt, 1943, *Wilson Bull.*, 55:3–7.)

Subspecific differences are elaborately illustrated in all cases, even when poorly defined or based on size alone (Aleutian and Eastern Green-winged Teals, Plate IX, p. 98; Crozet and Kerguelen Pintails, Plate XIV, p. 134; and the Cinnamon Teals, Plate XIX, p. 182).

Never before have color plates of ducklings of all the species of waterfowl been presented in one work—truly a major contribution in itself.

The distribution maps show no overlap in winter and summer ranges for any species. This adds to the clarity at the expense of some accuracy. Neither maps, keys nor plates are cross-referenced; this eliminates possibility of the usual errors. All can be readily found by reference to the index where scientific and common names are listed separately.

By a man's biases you shall know him, and so from his book you will know those of Jean Delacour. That he is a sportsman is revealed when he says of the Blue-winged Teal, "They are good sporting birds but their flesh is not of very good quality" (p. 163). When he says a species "is rather coarse in shape" he reveals the poultryman's eye. As an ardent aviculturist he sees the opportunities to use aviculture as a means for preserving endangered species (such as the Laysan Teal). Speaking of the Auckland and Campbell islands he says, "Since their islands have been invaded by man and the animals that follow him. Brown Teal have considerably decreased in numbers and are now facing extinction. The resources of aviculture should be employed for their perpetuation" (p. 81). The fact that the New Zealand Grey Duck is rapidly being lost through progressive hybridization with introduced Mallards gets but passing mention.

Apparently the English editors could not resist correcting American spelling (program to programme, p. 48) even in a direct quotation!

As I read through this fascinating and beautiful volume I was intrigued by the generalizations that seemed to be emerging: The tendency for island populations to become white-spotted or darker and smaller in stature; the frequency of loss of one or the other plumage (eclipse or nuptial) in the southern hemisphere; the breakdown of sexual dimorphism in this region, and the increasing frequency of the male staying with his mate and aiding in rearing of the young; and the rarity of seasonal migration from austral areas. Anticipation of an elaboration of these and many other biological features will make us eagerly await the appearance of the final volumes in this series.—William H. Elder.

PROCEEDINGS OF THE FORTIETH ANNUAL MEETING

BY AARON M. BAGG, SECRETARY

The Fortieth Annual Meeting of the Wilson Ornithological Society was held at Rockland, Maine, from Thursday, June 11, to Sunday, June 14, 1959. The meeting was sponsored by the Portland Society of Natural History, the Farnsworth Museum, and the Maine Audubon Society. The Local Committee, under the efficient co-chairmanship of Christopher M. Packard and Wendell Hadlock, performed a truly outstanding piece of work in organizing the meeting and in providing the 302 registered members and guests with all conceivable information on events and field trips.

Four sessions were devoted to papers, and two business meetings were held, all in the Farnsworth Museum. The meeting opened with an informal reception in the museum on Thursday evening, when Carl W. Buchheister, of the National Audubon Society, presented the fine film, *Pastures of the Sea*. Thursday evening was also the occasion for the meeting of the Executive Council, in the museum auditorium. On Friday evening, 239 members enjoyed a real Downeast Clambake, featuring steamed clams, lobsters, and corn. The Annual Dinner was held on Saturday evening at the Thorndike Hotel, with Lawrence H. Walkinshaw presenting the President's Address. This was followed by the first public showing of a most impressive color film, *Sea, Ice, and Fire*, made in Iceland in 1958 by Olin Sewall Pettingill, Jr., whose commentary was as colorful as the superb pictures which he described. The Local Committee had decorated the tables attractively, and souvenir plates featuring puffins were at each place setting. At the head table, each officer received a Wilson's Warbler, carved in wood and kindly presented by Mrs. Dorothy Washington, and a treasure chest of Maine seafood delicacies.

Early-morning field trips to nearby coastal and inland areas were scheduled for Friday and Saturday. On Sunday, through the courtesy of the United States Coast Guard, 168 persons sailed in the buoy-tender *Laurel* to the puffin colony on Matinicus Rock—a sea-cruise which, though attended by day-long rain, was highly successful birdwise; in addition to the Common Puffins, species seen included Northern Phalarope, Sooty Shearwater, Wilson's Petrel, Arctic Tern, Common Eider, and Black Guillemot. Field parties also left on Sunday for Mt. Desert Island, under the leadership of James Bond (species seen included Red Crossbill, Common Raven, Winter Wren, Bay-breasted Warbler), and for Mt. Katahdin, under the leadership of Mr. and Mrs. Wendell Taber.

First Business Session

President Walkinshaw called the meeting to order at 9 a.m., Friday, June 12. Mr. Wendell Hadlock, Director of the Farnsworth Museum, and Mr. Edward F. Dana, President of the Portland Society of Natural History, welcomed the members and guests of the Wilson Ornithological Society. President Walkinshaw responded on behalf of the Society.

The Proceedings of the Thirty-ninth Annual Meeting, as published in *The Wilson Bulletin* for September, 1958, were corrected on the matter of dues. On April 25, 1958, the meeting of members voted to amend the Constitution, as duly proposed previously by mail. Article II, Section 3, Sentence 1 was changed to become: "The amount of the annual dues of Active Members and Sustaining Members shall be determined by the Executive Council in accordance with current requirements." Empowered by this amendment, the Council set the Active Membership dues at $4.00 per year, and the Sustaining Membership dues at $6.00 per year. On motion by Harold Mayfield, seconded by Francis Harper, the members voted the adoption of this correction in the Proceedings of the

Thirty-ninth Annual Meeting. On motion by Mayfield, seconded by Frank Preston, the members approved the Proceedings as corrected.

Secretary's Report

The secretary, Aaron M. Bagg, summarized the principal actions taken at the Thursday evening Executive Council meeting as follows:

1. The Council voted to accept the invitation of the Tennessee Ornithological Society to the Wilson Society to hold its 1960 meeting at Gatlinburg, Tennessee, during May 5–8, 1960.
2. The Council voted to accept the invitation of the Federation of Ontario Naturalists, the Audubon Society of Canada, and the Royal Ontario Museum, to the Wilson Society, to hold its 1961 meeting in the Muskoka District of Ontario in June, 1961.
3. The Council voted to accept an invitation to the Wilson Society to hold its 1962 meeting in Indiana.
4. The Council re-elected H. Lewis Batts, Jr., as editor of *The Wilson Bulletin*.

Treasurer's Report

The treasurer, Ralph M. Edeburn, submitted the following report on the finances of the Society:

REPORT OF TREASURER FOR 1958

GENERAL FUND

Balance as shown by last report, dated December 31, 1957			$ 1,567.07
RECEIPTS			
Dues:			
Active memberships	$6,611.15		
Sustaining memberships	1,942.10	$8,553.25	
Subscriptions to *The Wilson Bulletin*		602.00	
Sale of back issues and reprints of the *Bulletin*		160.09	
Interest on Investments and Savings		533.50	
Library Book Fund		65.50	
Gifts:			
September Color Plate (anonymous donor)	$550.29		
Miscellaneous	118.00	668.29	
Refund—Registration Wheeling Meeting		38.70	
Miscellaneous		7.39	10,682.72
Total Receipts			$12,195.79
DISBURSEMENTS			
The Wilson Bulletin—printing and engraving		$5,378.49	
The Wilson Bulletin—mailing and maintenance of mailing list		830.49	
Editor's Expense—clerical, postage, and telephone		120.00	
Treasurer's Expense			
Stamped envelopes and postage	$166.80		
Printing	140.62		
Safety deposit box (2 years)	6.60		
Typing membership	51.00		
Supplies and miscellaneous	12.74	377.76	
Secretary's Expense			
Stamped envelopes and postage	$ 91.28		

Announcements—annual meeting	93.41		
Programs—annual meeting	55.78	240.47	
Back issue distribution		25.00	
Purchase reprints and books		19.32	
Committee expenses—printing and postage		99.52	
September Color Plate (anonymous donor)		550.29	
Louis Agassiz Fuertes Research Grant		75.00	
Miscellaneous		4.75	
Total Disbursements			$ 7,721.09
Balance on hand in Twentieth Street Bank, Huntington, West Virginia, December 31, 1958			$ 4,474.70

Endowment Fund

Balance in Savings Account as shown by last report, dated December 31, 1957			$ 1,234.61
RECEIPTS			
Life Membership payments		$1,998.00	
Patron Josselyn Van Tyne (posthumously) (anonymous donor)		400.00	2,398.00
6 shares Mass. Investor's Trust at $13.41 (included below)			
Total Receipts			$ 3,632.61
DISBURSEMENTS			
Louis Agassiz Fuertes Research Grant		$ 25.00	
Purchased—25 Shares Owens-Illinois 4% Cum. Stock		2,487.03	
Total Disbursements			$ 2,512.03
Balance in Savings Account, Twentieth Street Bank, Huntington, West Virginia, December 31, 1958			$ 1,120.58
SECURITIES OWNED			
U. S. Treas. Bonds, 4%, Mature Oct. 1, 1969 (maturity value, $3,000.00)	$3,045.00		
U. S. Savings Bonds, Series "F," dated February 1, 1947 (maturity value, $2,000.00)	1,924.00		
U. S. Savings Bonds, Series "F," dated April 1, 1948 (maturity value, $2,000.00)	1,858.00		
U. S. Savings Bonds, Series "F," dated October 1, 1948 (maturity value, $1,450.00)	1,316.70		
U. S. Savings Bonds, Series "F," dated April 1, 1950 (maturity value, $1,000.00)	874.00		
Total Value of U. S. Bonds		$ 9,017.70	
Kaiser Aluminum and Chemical Co. Stock, 4¾% (15 shares at $110.00)		1,650.00	
Massachusetts Investor's Trust (388 shares at $13.41)		5,203.08	
Fireman's Fund Insurance (70 shares at $59.00)		4,130.00	
Owens-Illinois Glass Co., 4% Cum. Preferred (25 shares at $99.25)		2,481.25	
Total Securities Owned			$22,428.03
Total in Endowment Fund, December 31, 1958			$23,602.61

Bonds listed at redeemable value December 31, 1958
Stocks listed as of closing prices December 31, 1958

Respectfully submitted,
/s/ Ralph M. Edeburn
Treasurer

Research Grant Committee

Harvey Fisher, chairman, reported by letter that since, through a misunderstanding, the Committee had felt that no funds were available, no grants were made in 1958.

At its June 11, 1959, meeting, the Council voted $100.00 from General Funds, if no other funds are available, for the Fuertes Research Grant for 1959, and $75.00 from General Funds to make up the $100.00 for 1958. The Council also voted that the Fuertes Research Grant be made permanent until rescinded.

Therefore, as reported by Dr. Fisher, the Committee is moving forward for 1959–1960.

Membership Committee

Howard F. Young, chairman, reported by letter that the names of 188 new members, enrolled since the 1958 meeting, are posted for inspection by the members, to be elected at the final business meeting. Seventeen of these are Life Memberships, and 15 are Sustaining. Recent downward trends in membership are apparently halted, with membership at present approximately 1485, compared with 1475 as in the last report. In addition, there are 202 institutional subscriptions to the *Bulletin*.

Library Committee

William A. Lunk, chairman, reported that:

During the 12 months just completed, the committee has been reorganized, following the resignation of H. Lewis Batts, Jr., as chairman, with the appointment of Dr. and Mrs. W. Powell Cottrille as additional members.

Through meetings and correspondence, a number of matters pertaining to policy and procedure have been clarified. The question of adjusting the stocks of back issues of *The Wilson Bulletin* has not, to the committee's knowledge, been satisfactorily resolved; sizable surpluses of certain issues are still on hand.

Of major concern has been the incorporation of the library of the late Josselyn Van Tyne. The gift of an additional 200 reprints, and 130 books and pamphlets, from this library, by Mrs. Van Tyne, constituted the largest single addition to the Society's holdings. All of the Van Tyne collection has been placed on permanent loan to the Society, and is available to W.O.S. members for use as an integral part of the Josselyn Van Tyne Memorial Library. Cataloguing of the entire collection is proceeding. In accordance with the name change of the library, all new material (from whatever source) is being marked to conform. The permanent memorial book plate is not yet ready.

A list of items from the Van Tyne collection which are considered surplus has been prepared. This has been circulated so far, successively, to six individuals to whom Mrs. Van Tyne had asked that preference be given, and to a few other persons. A number of items have been sold, and the proceeds (perhaps $100.00 in all) have been placed in the Library's New Book Fund. The list will be available for circulation at the Rockland annual meeting; and it will be further submitted to individuals and institutions to be selected, before other means are employed to dispose of the residue. The New Book Fund is constantly being employed to purchase works, not otherwise provided, which are felt to be desirable tools to have at the disposal of the membership. There is still a small balance, the exact amount of which will be shown on the Treasurer's report.

Routine library matters are being competently handled by Technical Aid Norman Ford (Bird Division, Museum of Zoology, University of Michigan) who thus devotes a substantial share of his time to W.O.S. business. The close relationship between the Society and the University of Michigan continues to work to mutual advantage, with the latter supplying much-needed housing, binding, care, and general maintenance facilities, while profiting from the additional wealth of source material.

The library continues regularly to receive 93 journals, 81 as exchanges and 12 by donation. In addition, 84 separate donations have been reported: 561 reprints, 156 books, 252 journals, 13 pamphlets, 7 newsletters, 7 translations, and 1 phonograph record. Approximately 50 out-of-town loans were made during the year, involving some 150 separate publications—and this in addition to extensive on-the-spot use of the library by individuals on campus or visiting.

The committee wishes to express appreciation for the continued interest of the members, but urges even wider support for our whole library program. Donations, requests, and constructive suggestions are all equally solicited.

Endowment Committee

Olin Sewall Pettingill, Jr., reported 23 new Life Members and 3 Patrons.

Temporary Committees

The President appointed the following temporary committees:

Auditing Committee

N. Bayard Green, Chairman
Robert P. Van Blaricom
Rachael Wilson

Nominating Committee

Maurice Brooks, Chairman
Fred T. Hall
Margaret M. Nice

Resolutions Committee

Andrew J. Berger, Chairman
William A. Dyer
Ralph S. Palmer

Second Business Session

The final business session was called to order at 3:05 p.m., Saturday, June 13.

Olin Sewall Pettingill, Jr., spoke briefly on Society finances, mentioning the difficulty in increasing the membership, the need for new members, and the need for gifts to endowment and research.

The applicants for membership whose names were posted during the meeting were elected to membership.

Report of the Auditing Committee

The committee reported by letter that they had examined the books and accounts of the Treasurer and found them to be in good order.

Report of the Resolutions Committee

WHEREAS The Wilson Ornithological Society is in session at its Fortieth Annual Meeting in Rockland, Maine,

BE IT RESOLVED that the Society express its appreciation to the Local Committee under the leadership of Christopher M. Packard and Wendell Hadlock for the excellent planning and efficient organization that have made this meeting so enjoyable and interesting to the people in attendance;

AND BE IT FURTHER RESOLVED that the Society express its thanks to the sponsoring organizations, the Portland Society of Natural History, the Farnsworth Museum, and the Maine Audubon Society, for making available such fine facilities in such a pleasant setting for this annual gathering;

AND BE IT FURTHER RESOLVED that the Society express its thanks to the United States Coast Guard, and to Lt. Com. R. L. Davis, Commanding Officer of the *Laurel*, and to her officers and crew, for their generous hospitality aboard ship;

AND BE IT FURTHER RESOLVED that the Society express its sincere thanks to Ralph M. Edeburn for his faithful and effective service as Treasurer of the Society;

AND BE IT FURTHER RESOLVED that the Society express its thanks to Keith L. Dixon for his untiring efforts in maintaining, during his term as Editor, the high standard of *The Wilson Bulletin.*

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, Lawrence H. Walkinshaw; First Vice-President, Harold F. Mayfield; Second Vice-President, Phillips B. Street; Secretary, Aaron M. Bagg; Treasurer, Merrill Wood; Elective Member of the Executive Council, Ralph M. Edeburn (term expiring 1962).

The report of the committee being accepted, and there being no nominations from the floor, the Secretary was instructed to cast a unanimous ballot for these nominees.

Papers Sessions

Friday, June 12

Banding Symposium arranged by James Baird, *What Is Banding Presently Contributing to Ornithology?* (papers 1 through 3)

1. Carl W. Helms, Hatheway School of Conservation Education, Lincoln, Massachusetts. *Energetics and Annual Cycle—What Can Banders Contribute?*, slides.
2. Charles E. Huntington, Bowdoin College, Brunswick, Maine. *A Banding Study of Leach's Petrel* (Occanodroma leucorhoa), slides.
3. Hubert Kluijver, Institute for Ecological Research, Arnhem, Netherlands (on Fellowship with Massachusetts Audubon Society). *Habitat and Reproductive Rate in Great Tit* (Parus major), slides.
4. John S. Webb and David Kenneth Wetherbee, Patuxent Research Refuge, Laurel, Maryland. *Southeastern Breeding Range of* Molothrus ater, slides.
5. Aaron M. Bagg, Dover, Massachusetts. *Aberrant "Fee-bee" Song of Chickadees on the Island of Martha's Vineyard, Massachusetts.*

Migration Symposium arranged by Chandler S. Robbins, *Current Bird Migration Research* (papers 6 through 12)

6. Robert E. Richardson, Lincoln Laboratory, Massachusetts Institute of Technology. *Radar Observation of Birds in the Vicinity of Cape Cod*, movies and slides.
7. William H. Drury, Jr., Massachusetts Audubon Society. *Radar and Bird Migration.*
8. Ian C. T. Nisbet, Cambridge, Massachusetts. *Reversed Fall Migration on Atlantic Coastal Islands and Its Relation to Wind-drift*, slides.
9. David B. Wingate, Hamilton, Bermuda. *A Discussion of Recent Records of North American Birds Occurring in Bermuda during Migration.*

10. James Baird, Norman Bird Sanctuary, Middletown, Rhode Island. *An Analysis of the Fall Migration in 1958 through a Study of the Banding Records from Various Coastal Stations*, slides.
11. Robert J. Newman, Museum of Zoology, Louisiana State University. *Further Studies of the Hour-to-Hour Variation in Nocturnal Migration*, slides.
12. Helmut C. Mueller, University of Wisconsin, Madison. *Weather and Fall Hawk Migration at Cedar Grove, Wisconsin*, slides.

Saturday, June 13

Wood Warbler Symposium arranged by George M. Sutton, *A Survey of the Parulidae* (papers 13 through 19)

13. Kenneth C. Parkes, Carnegie Museum, Pittsburgh, Pennsylvania. *Remarks on Taxonomic Relationships among North American Parulidae.*
14. James Bond, Academy of Natural Sciences, Philadelphia, Pennsylvania. *Evolution and Speciation of West Indian Parulids.*
15. Eugene Eisenmann, American Museum of Natural History, New York City. *Evolution and Speciation of Middle and South American Parulids.*
16. Lawrence H. Walkinshaw, Battle Creek, Michigan. *Life History Studies and the Contribution These Have Made to an Understanding of the Parulidae.*
17. Stephen W. Eaton, St. Bonaventure University, St. Bonaventure, New York. *The Comparative Approach in Studies of the Parulidae.*
18. Harold F. Mayfield. Waterville, Ohio. *Why Is the Kirtland's Warbler So Rare?*
19. Val Nolan, Jr., University of Indiana, Bloomington. *Population Dynamics in the Prairie Warbler.*
20. Tudor Richards, Dublin, New Hampshire. *Some Recent Changes in the Bird Life of the Lake Umbagog Region of Northeastern New Hampshire*, slides.
21. Eleanor E. Dater, Ramsey, New Jersey. *Nesting Sites of Lawrence's Warbler* (Vermivora lawrencei).
22. Allen H. Morgan, Massachusetts Audubon Society. *A New Technique for Photographing Birds*, movies.
23. Walter R. Spofford, State University Medical College, Syracuse, New York. *Feeding Habits of Appalachian Golden Eagles*, movies.
24. Lawrence I. Grinnell, Laboratory of Ornithology, Cornell University, Ithaca, New York. *Tropical Birds of Queensland, Australia*, movies.

Attendance

Members and guests who registered totaled 302. Twenty-four states, the District of Columbia, and the Canadian Provinces of New Brunswick, Ontario, and Quebec were represented, as were The Netherlands and Kenya.

From **California**: 2—*Pasadena*, Dr. and Mrs. Robert L. Taylor.

From **Connecticut**: 11—*Fairfield*, Mr. and Mrs. Edward A. Beddall, Mrs. Roy Larsen; *Greenwich*, Mr. and Mrs. John C. Schmid; *Hartford*, Mr. and Mrs. G. Hapgood Parks; *New Haven*, Philip S. Humphrey; *Old Lyme*, Roger Tory Peterson; *West Hartford*, Mr. and Mrs. E. A. Bergstrom.

From **Florida**: 3—*Coconut Grove*, Wayne Short; *Fort Myers*, Mr. and Mrs. George C. Erskine.

From **Illinois**: 4—*Blue Island*, Karl E. Bartel; *Chicago*, Mrs. Amy C. Baldwin, Eleanor Hudgeon, Catharine Schaffer.

From **Indiana**: 7—*Bloomington*, Val Nolan, Jr.; *Connersville*, Miss Edna Banta; *Mishawaka*, Mr. and Mrs. John W. Conboy; *Muncie*, Miss Ellen Heine, Mr. and Mrs. Harold A. Zimmerman.

From **Iowa**: 3—*Cedar Rapids*, Esther Pieters, Pauline Wershofen; *Davenport*, Peter Petersen, Jr.

From **Kansas**: 3—*Wichita*, Mr. and Mrs. Albert W. Briggs, Margaret Briggs.

From **Kentucky**: 6—*Louisville*, Fred Hunt, Eleanor Lovell, Mr. and Mrs. Harvey B. Lovell, Mr. and Mrs. Frederick W. Stamm.

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(See committee reports inside.)

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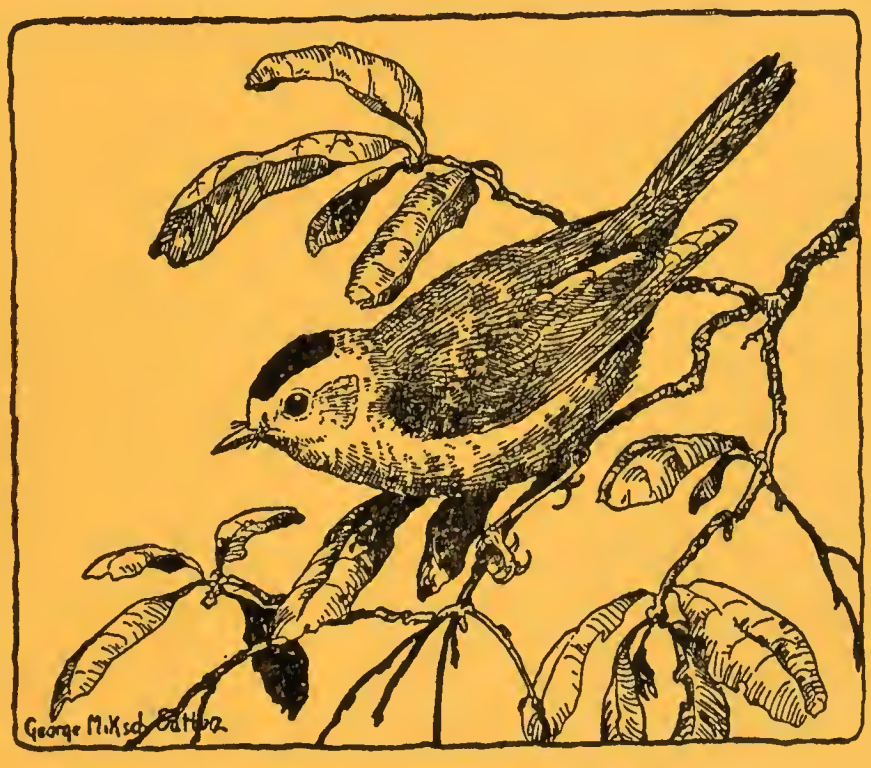

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THE WILSON BULLETIN

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Rallus mirificus Parkes and Amadon, type. One-half natural size.
Painting by Lloyd Sandford.

A NEW SPECIES OF RAIL FROM THE PHILIPPINE ISLANDS

BY KENNETH C. PARKES AND DEAN AMADON

Although Mayr (1957:35) predicted that no more than 20 good species of birds would be found in the decade following 1955, the rate at which such discoveries have been announced in the past few years suggests that Mayr's figure may well have been too low. Some of the new species turned up in recent years have reposed in collections, unrecognized, for a long time. Most of the rest have either been small, inconspicuous passerines, easily overlooked, or have come from remote mountains or jungles, attainable only by major expeditions.

Among a collection of some 900 birds from the Philippine island of Luzon, purchased jointly by Carnegie Museum and the American Museum of Natural History in 1959, we were astonished to find no fewer than seven examples of what appears to be a new species of *Rallus*, three of which were taken in the immediate vicinity of a town situated on a main road, only about 50 miles from the city of Manila. In view of the surprising nature of such a discovery, it seems appropriate to call the new rail

Rallus mirificus[1], new species

Type: American Museum of Natural History no. 708,000; adult female; Santa Fe (Dalton Pass), near Aritao, Nueva Viscaya Province, Luzon, Philippine Islands; collected November 20, 1958, by A. Concepcion.

Description of Type (Capitalized color names from Ridgway [1912]): Crown and nape Chestnut-Brown, lightening to Chestnut on hindneck, near Auburn on forehead; a narrow line of Sayal Brown between forehead and lores; lores and cheeks Deep Olive-Gray washed with Chestnut-Brown, paling through Light Olive-Gray to white on throat; anterior back near Brussels Brown, darkening toward Prout's Brown on posterior back and rump; feathers of anterior back with vaguely-defined blackish central areas which do not reach tip; feathers of mid-back with small black-bordered spots of Pale Pinkish Buff along edges, these spots decreasing in both size and abundance anteriorly and posteriorly; scapulars Brussels Brown, the edges of the feathers with black-bordered bars of Pinkish Buff; upper tail coverts and rectrices somewhat blacker than Mummy Brown, with small black-bordered marginal spots of Pinkish Buff; breast Deep Gull Gray, heavily washed with Brussels Brown on sides of breast, less heavily across upper breast; center of abdomen Pale Gull Gray; sides Prout's Brown, darkening posteriorly through Mummy Brown to a blacker color (but not black) along flanks, all of these feathers being heavily barred. The bars range from Pale Pinkish Buff anteriorly to Light Pinkish Cinnamon posteriorly, and are narrowly bordered with black.

[1] Latin, "causing wonder."

Toward the sides of the abdomen, the ground color of the feathers approaches Deep Grayish Olive, with whiter bars lacking the black borders. Under tail coverts Olivaceous Black, broadly tipped with Light Pinkish Cinnamon. Larger upper wing coverts like scapulars, smaller chiefly Brussels Brown; small feathers along bend of wing white; inner secondaries Brussels Brown, becoming blacker toward center of feather, with prominent black-bordered marginal bars of Pale Pinkish Buff or Pinkish Buff, best developed on outer margin; primaries and outer secondaries very dark brown, almost black, the latter with a few small Pinkish Buff spots along outer margin; under wing coverts Olivaceous Black, mixed with white. Soft-part colors in life probably about as shown in Mr. Sandford's painting (frontispiece), judging from comparison of dried parts with those of related species for which color notes are available.

Variation in Color: There are minor variations in shade, particularly of the reddish brown of crown and neck, among three of the four presumed adult specimens. The fourth, a female from the type locality, is markedly darker and richer in all of its shades of brown, and has fewer and smaller bars on wings and scapulars. Its flanks are somewhat blacker, although not the pure black of *Rallus pectoralis*.

Three specimens are assumed to be immature individuals. They lack the decided reddish-brown color of the crown and hind neck, being various shades of dark grayish brown in these areas, and are grayer on the cheeks and upper breast. Their bills also appear to have been darker in life than those of the presumed adults.

Range: Known only from two localities in the western foothills of the southern half of the Sierra Madre Mountains of Luzon, Philippine Islands: Papaya, Nueva Ecija Province (about 50 miles north of Manila), and the type locality, near Aritao, Nueva Viscaya Province, about 70 miles north of Papaya.

Relationships: The new species appears to be most closely related to *Rallus pectoralis* Temminck, a species ranging from Flores in the Lesser Sunda Islands to New Guinea, Australia and Tasmania. All races of *pectoralis*, however, have the back conspicuously streaked with black, a condition only vaguely suggested by the dark central area of the basal portions of back feathers of *mirificus*. In all races of *pectoralis* the reddish brown of the head and hind neck is much brighter and more reddish than in *mirificus*, and in most races is more or less heavily streaked with black, continuous with the black streaking of the back. There is no suggestion of such streaking on the head and neck of *mirificus*. In all races of *pectoralis* the barring of the abdomen and flanks is crisply black and white rather than dark brown and buffy as in *mirificus*. Judging from the color of dried bills and from informa-

tion recorded by collectors of *pectoralis* (soft-part color notes are unfortunately not available for *mirificus* at this time), the bill in all races of *pectoralis* is more extensively red, and of a paler color, than that of *mirificus*. The toes and tarsi of *mirificus* also appear to be darker. The bill of *mirificus* is proportionately shorter than that of any race of *pectoralis* (see measurements, beyond).

Of the known subspecies of *Rallus pectoralis*, the closest approach to *mirificus* in appearance is shown by the two small-billed races, *exsul* Hartert from Flores, and *insulsus* Greenway from northeastern New Guinea, both known only from their respective type specimens. Both *exsul* and *insulsus*, however, are clearly races of *pectoralis* (although *insulsus* was originally described as a race of *Rallus striatus*, which is quite a different species), having the pale bill, streaked back, and black-and-white barring typical of *pectoralis* as a species. The streaks on crown and hind neck, prominent in some races of *pectoralis*, are only faintly indicated in *exsul* and *insulsus*, but are completely absent in *mirificus*.

TABLE 1

MEASUREMENTS OF *RALLUS MIRIFICUS* AND *RALLUS PECTORALIS* (IN MM.)

Specimens	Wing (flat)	Culmen from feathers	Tarsus	Middle toe and claw
Rallus mirificus ad. ♀ (TYPE), Santa Fe, Luzon, P.I., Nov. 20, 1958	108	27	30	37
ad. ♀, Santa Fe, Luzon, P.I., Nov. 18, 1958	106	25	29	36
ad. ♀, Papaya, Luzon, P.I., Nov. 16, 1958	106	26	29	38
ad. ♂, Santa Fe, Luzon, P.I., Nov. 18, 1958	—	24	28	35
imm. ♂, Papaya, Luzon, P.I., Nov. 16, 1958	107	26	30	37
imm. ♂, Papaya, Luzon, P.I., Nov. 16, 1958	106	25	28	33
imm. ♂, Santa Fe, Luzon, P.I., Nov. 19, 1958	103	25	29	34
Rallus pectoralis exsul ad. ♂ (TYPE) South Flores Island	100	27	29	36
R. p. insulsus ad. ♀ (TYPE) Wau, New Guinea	99	27	29	34
R. p. alberti ad. ♂ Angabunga River, New Guinea	92	30	32	37
R. p. captus ad. ♂ Mount Hagen, New Guinea	100	35	34	41
R. p. mayri ad. ♂ Kofo, Arfak, New Guinea	104	39	34	39
R. p. pectoralis ad. ♂ Victoria, Australia	104	33	30	35
R. p. brachipus ad. ♂ Tasmania	103	31	31	39

Rallus mirificus and *R. pectoralis* may form a superspecies, but the clear-cut differences between them, the remoteness of their ranges, and the absence of representative forms elsewhere, leave little doubt that they are specifically distinct.

The widespread Oriental and East Indian species, *Rallus striatus*, occurs side by side with *mirificus* on Luzon, and is superficially similar to it. *Striatus*, however, is a larger bird, with a much stouter bill, heavier tarsi and toes, a heavily spotted back, and *barred* flight feathers, among other differences.

Measurements: See Table 1. Judging from other specimens in the same collection, the sexing of the *mirificus* specimens may not be completely reliable. Measurements of various races of *Rallus pectoralis* are appended for comparison. Note that in *mirificus* the culmen length is 25% or less of the wing length, in *pectoralis* 27% or more.

We are grateful to J. C. Greenway, Jr., of the Museum of Comparative Zoölogy, for permission to examine the unique type of *Rallus pectoralis insulsus*.

Literature Cited

Mayr, E.
1957 New species of birds described from 1941 to 1955. *Jour. für Ornith.*, 98:22–35.
Ridgway, R.
1912 Color standards and color nomenclature. Washington, D.C.

CARNEGIE MUSEUM, PITTSBURGH, PENNSYLVANIA; AND AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK, NEW YORK, OCTOBER 12, 1959

THE SONG, NEST, EGGS, AND YOUNG OF THE LONG-TAILED PARTRIDGE

BY DWAIN W. WARNER

So little is known about the habits and distribution of the Long-tailed Partridge (*Dendrortyx macroura*) that a summary of my observations on a few of the facets of the life of this species may be of interest. The nest and eggs have not been described.

The only detailed information on any of the large Middle American forest quail is that by Skutch on the Marbled Wood Quail (*Odontophorus gujanensis*) (1947. *Condor*, 49:217–232), to which the reader is referred for descriptions of similarities, as well as differences, between that species and *Dendrortyx macroura* in habits, voice, nest, and eggs.

The following observations were made during the period from September, 1953 through July, 1954, in the region of the Lagunas de Zempoala which lies on the border between the Mexican states of Morelos and Mexico and the Distrito Federal. The weather in this high and extremely rugged region, which borders the Balsas drainage system, is one of drastic and rapid changes through much of the year. The months of February to late April are dry, and few clouds gather over the mountains. Days are sunny and warm and the nights pleasantly chilly. This is the season of forest fires which, along with cutting, have altered the primeval beauty of this magnificent mountain forest of fir, pine, and oak in which there is a strong admixture of more characteristically lowland flora on the south-facing slopes.

During the months of December, January, and February frost occurs nearly every night. From May through the rest of the year clouds shroud this mountain mass most of the time, and mist and rain fall nearly daily. During the rainy months there occur severe thunderstorms which often culminate in light to heavy falls of hail, or "graniso," to depths of several inches. On June 29, 1954, snow accumulated to a depth of four inches over most of the Sierra de Ajusco above 2900 meters, of which Zempoala is a part. At dawn cold air which settles over these highlands during the night pours as a strong wind southward off the highlands toward the lowlands of Morelos.

In the mountains about the Valley of Mexico the Long-tailed Partridge, or "gallina del monte," is still fairly common in the least disturbed humid forests of fir–pine–oak at an altitude between approximately 2800 meters and 3300 meters. The species is very shy and, from my experience, extremely difficult to approach without a dog. It is both arboreal and terrestrial but spends much time on the ground, as indicated by extensive scratchings in the leaf litter and humus of its shaded home. On the other hand, flowers, flower buds, and fruits

are eaten from perches above ground in much the same manner as in the more arboreal species of grouse.

This quail is hunted successfully by only a very few people, who nearly always use a dog. I remember watching in amazement the first time a Mexican hunting companion heard quail. He quickly laid down his gun, removed his huarachos and all of his clothing except undershorts; then retrieving his gun, and beckoning to his silent dog, he disappeared without a sound into the forest. In about five minutes the dog barked; and nearby a quail flew from the ground to a branch about 15 feet above the ground, where it was shot.

The voice of this quail is seldom heard. Loud calling or singing began in late February, but these calls were heard only rarely even during the period from February to July, so that presence or absence of these birds in an area could not be determined by their vocalizations. No calling was heard other months of the year. I never heard more than two outbursts of song in one day in one area; and songs were heard only just after dawn and at dusk.

From a distance, as across a valley, the song is a loud, ringing *korr-EEE-oh, korr-EEE-oh, korr-EEE-oh, korr-EEE-oh,* which is taken up by other individuals in the same area, as well as by others in other places. Singing may continue for some 30 seconds to a minute, then cease abruptly, leaving no clear clues as to directions from which the songs really came or the numbers of birds involved. This is not the complete song but is really only the end. When singing birds are near the observer, a series of introductory notes are heard which begin as low, guttural, hooting sounds which rise rapidly in volume until the *korr-EEE-oh* sounds start without pause. These preliminary notes may be indicated best as *whoop, whOop, whOOp, whOOOp, WHOOOP, korr-EEE-oh,* etc. The two parts of the song are so different that it is difficult to believe at first that they are part of the same song. Mexicans who hunt this quail learn of its presence by other sounds unfamiliar to me.

Groups of adults apparently come together at feeding and dusting grounds even during the nesting period, and singing heard in July involved more than two birds in one small area.

Two adults were taken in steel traps set for large mammals in forest trails, and tracks were seen along trails, indicating that this quail may use trails in much the same manner as the Marbled Wood Quail reported by Skutch (*loc. cit.*). (See Fig. 1.)

Gonadal changes in adults, and observations on a nest, eggs, and young give some clues to breeding time and habits. A male taken in November had a left testis measurement of 8 × 4 mm. Testes of two males collected in February and early April measured 10 × 3.5 and 10 × 6 mm. The ovary of a female collected on April 20 had undergone considerable recrudescence, and the oviduct was approximately 5 mm. in diameter; and a female collected on June 21 had a soft-shelled egg in the oviduct, and 10 oocytes in the ovary ranging from 5 to 15 mm. in diameter. No brood patch was apparent on this bird, but

some feathers of the lower breast and belly were being replaced. Two downy young in early postnatal molt found June 6, and reports of young as early as late May show that nesting begins by late April or early May.

Two adult males weighed 450 and 455 grams; two adult females weighed 374 and 446 grams. The digestive tract of one bird contained flowers, flower buds, small green fruits and seeds. Others contained similar vegetable matter and arthropod remains.

FIG. 1. *Dendrortyx macroura* calling near Huitzilac, Morelos.

A nest with its clutch of eggs was found about four kilometers northwest of the village of Huitzilac, Morelos, along the road to the Lagunas de Zempoala. There the road skirts the Cañada de Oclacingo, which plunges away to the south from the slopes of Cerro Cuautepetl. The nest was located about one-half kilometer across the canyon in semi-open fir–pine–oak forest at an altitude of about 2900 meters. The slope at the nest site was very steep. Three hundred feet below the nest was a small level area planted in corn. Soil on the slope was very shallow with much rock exposed, but in most cases only the outward facing sides of the rocks were bare or were lightly covered with moss and

lichens. Soil cover consisted of a little leaf mold, much pine duff, and a few leaves.

The vegetation was dominated by tall, mature firs and pines, among which were a few gnarled oaks. The oaks were largely dead, and were covered with epiphytic mosses, lichens and other plants. All of the mature trees showed much fire damage. Many young trees 15 to 20 feet in height were present with firs growing in dense clumps dominating this stratum. Except in the clumps of fir, there was a dense growth of broad-leaved shrubs nearly everywhere. Two species of ferns were abundant as ground cover, and grasses were present in small scattered openings in the forest.

The nest was located eight feet west of two oaks, 50 feet tall, standing close together. At this site there was a rather open tangle of brush, at the base of which dead branches lay prostrate on the ground. They jutted out from a two-foot-high rock exposure so that some touched the ground several feet out from the base of this vertical exposure of rock. A matting of twigs, pine needles and leaves had accumulated several inches thick on the prostrate branches. This matting, impervious to light and probably to rain, formed the sloping roof of a cavity three or four feet long and two feet wide at ground level. The inner wall was formed by the rock face. In this cavity was the nest to which the birds had access through a single opening about six inches wide at a slight angle outward from the rock side at the northeast end of the cavity.

Leading to the cavity entrance were two obvious trails, both probably created by adult quail in approaching and leaving the nest. One of the trails extended straight out from the nest entrance toward the two oaks for a distance of about three feet. The other turned sharply from the entrance and extended for about five feet through the tangle of twigs and brush at the lower edge of the cavity roof. The latter path was the more heavily used.

The nest, a shallow depression well lined with fine grasses, lay 12 inches from the cavity entrance and close to, but not touching, the rock wall. Only a small part of the dark cavity was occupied by the nest. Up to a distance of eight feet, and only from near ground level, all that could be seen of the bird on the nest was the bright red bill.

At 3:00 p.m. on July 1, when Allan R. Phillips, two other companions, and I visited the nest site, one adult quail was sitting on the nest. The bird remained there for about five minutes while we watched and took photographs. When we had approached cautiously to within eight feet, the bird quietly left the nest by the "switch-back" path, and disappeared in a few seconds. The nest contained six eggs, two of which were collected. Cesáreo Jimenez reported that at 4:00 p.m. on the previous day the nest had contained only four eggs and that an adult was on the nest. "Several" days before that, in the afternoon, only two eggs were present, and an adult was on the nest.

The two eggs which were collected were fresh. Each weighed 28.3 grams; they measure 49.0 × 33.4 and 48.5 × 33.5 mm. In color they are pale cream and are lightly and evenly spotted with light brown, the spots being of varying sizes with the larger ones nearly one millimeter in diameter. (See Fig. 2.)

When we visited the nest three weeks later, all that remained were scattered feathers of an adult quail, broken egg shells and a distorted nest cavity.

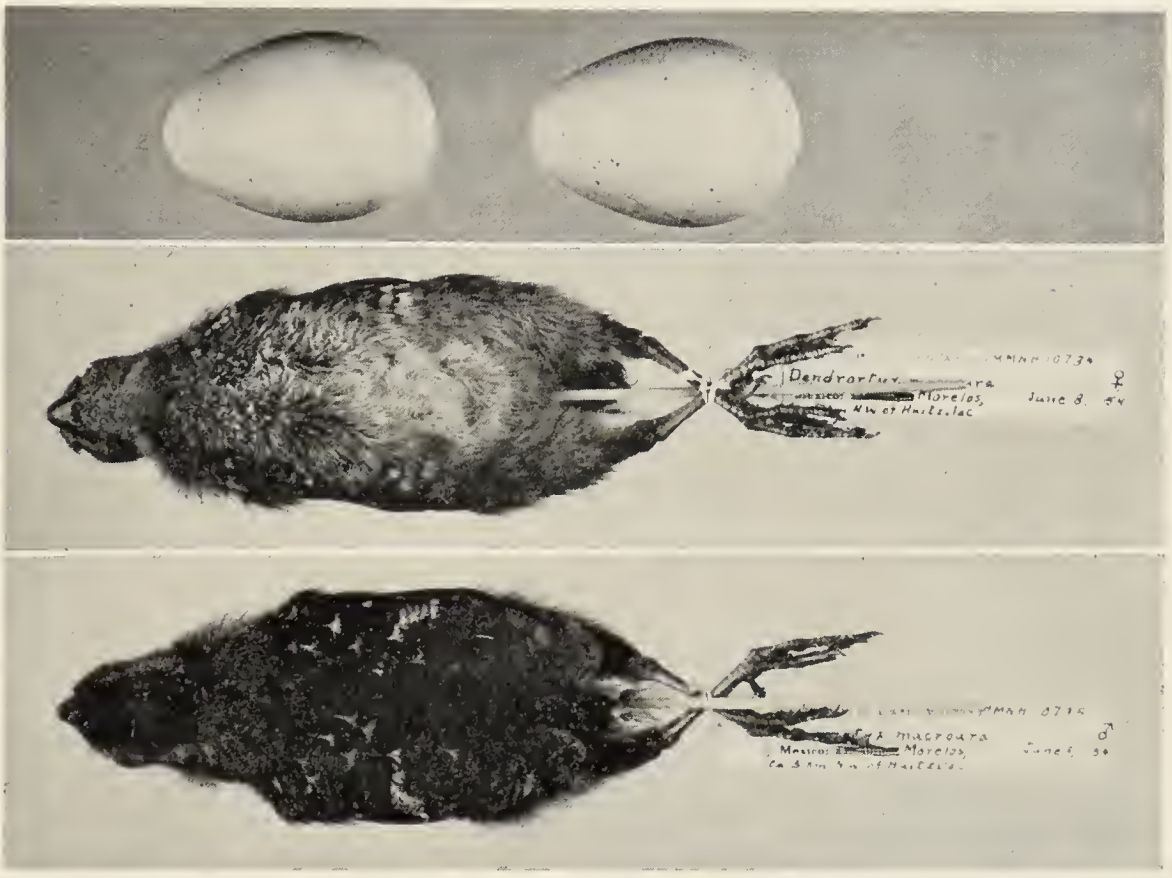

Fig. 2. Eggs and young of *Dendrortyx macroura.*

On June 8, 1954, I obtained in Huitzilac two live young, a male and female, which had been found together two days before on the south slope of Cerro Cuautepetl at an altitude of about 3000 meters. Both are in natal down except for some juvenal feathers among the interscapulars, scapulars, and on the wings and sides of the breast and belly. The wing of the male measures 51 mm. in length. On each wing only seven primaries could be found, and the No. 1 secondary had not appeared. In life the eye was olive-gray. The tip and anterior tomial region of the upper mandible, and the anterior two-thirds of the lower mandible were light orange-red; the rest of the bill was blackish. The tarsi and toes were light orange-red, darker posteriorly on the tarsi and on the soles. (See Fig. 2.)

Apparently the juvenal plumage has not been adequately described. Ridgway and Friedmann (1946. *U. S. Nat. Mus. Bull.*, 50, pt. 10, p. 246), in describing the juvenal plumage of *D. m. diversus*, state that this plumage is similar to the adult plumage with a few minor qualifications. Although the specimens at hand are in early postnatal molt, enough of the juvenal plumage shows both dorsally and ventrally to indicate that this plumage is similar in basic pattern to that in other Odontophorinae. The most obvious characters of this plumage are in the pattern of the breast, belly and back where the white shaft streaks expand near the tips, forming large V's or broad white bars at the ends of the feathers. The rest of the feather is blackish in the middle and browner at the base, the brown extending farther out on the lateral sides of the feathers of the back. The over-all impression, then, is of a spotted or barred young bird which is very different from the adult.

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NEW LIFE MEMBER

Ormsby Annan, a graduate of Harvard University (A.B.) and Northwestern University (M.S. and Ph.D.), is now a member of the teaching faculty of Barat College, Lake Forest, Illinois. Dr. Annan is interested in external and internal influences on the annual cycle of birds, and in educational nature photography. He is a member of the A. O. U., Cooper Ornithological Society, Ecological Society of America, and state ornithological societies of Illinois, Iowa and Florida.

LIFE HISTORY NOTES ON THE LEAST TERN

BY IVAN R. TOMKINS

It is amazing how one small mite of song in our vast complex of saline marshes, rivers and beaches, can mean so much. Absent, it is not missed, but when suddenly it is heard again after a time without it, one senses that something was missing before but now everything falls into proper perspective and there is order and beauty again—an order that is like a framework, incomplete in detail to let imagination have sway, yet comforting in its integrity. We may now and then fit some odd-shaped bit into the framework, to be tested by later observation. Fragments gleaned from the writings of others may tentatively bridge some of the gaps, yet there is always room for imaginative thought, controlled imagination fully heedful of possible errors in our own work, or in our interpretation of what others have written. The picture will always be incomplete, for however much we learn, there are still things to be added without end.

When April and May bring the cheery notes of the Least Tern (*Sterna albifrons*) creaking overhead, one more piece of the summer scene fits into place. Smallest of the terns, diminutive, elegant, immaculate in its white and gray and black plumage, it will dive for fishes close to our boat, drift directly overhead at close range, sit on the railings of bridges where cars pass frequently, or make its nest close to habitations or human activities if conditions suit. On the nesting grounds it will dive within a few feet of one's head, then return to the eggs while the intruder is only 50 feet away.

There have been two times when the species was numerous in this locality (Savannah, Georgia), once in the 1880's and again in the 1920's and '30's. There also have been two lows, the first within the years from 1890 to 1920, the second in 1957.

Erichsen (1921) stated that since 1891 no eggs of this species had been taken in Chatham County, Georgia, but quotes Troup D. Perry that they nested in large numbers on the five miles of sandy beach of Warsaw (Wassaw) Island from 1885 to 1890. Erichsen began the study of birds as a young man about 1909. Perry was then 59 years old. Gilbert R. Rossignol began his egg collections in 1904, and was active from 1907 to about 1937. All three were friends and competent observers.

From Rossignol's egg record it appears that he did not find any Least Terns nesting until his first visit to Oysterbed Island (he called it Robinson's Island) on June 7, 1922, but on that day he collected 55 sets of Least Tern eggs, and some sets of Wilson's Plover (*Charadrius wilsonia*) eggs. Oysterbed Island was not large enough above tidal level to furnish suitable habitat for a

large colony, until a few years before the 1922 visit. In the 1880's it did not exist.

These data are not extensive, yet the evidence of great fluctuations needs to be presented, not only for present understanding, but also to guide observations in the future. I wonder if similar things have happened in other parts of the range. About the turn of the century such things were usually blamed on the plume hunting. Perhaps other factors were operating too.

In the 1920's and 1930's, this species was very abundant along the coast of Georgia and South Carolina, and it was believed that it was making a strong comeback after the slaughter for millinery purposes was outlawed a few years before. Today this tern's numbers have fallen off greatly, and the reason is not at all clear. Certainly human predation is not now the cause. In 1925, by conservative estimate, 2500 pairs nested on Oysterbed Island in the Savannah River Entrance. This island was sandy, relatively barren of vegetation, and about 3000 feet by 6000 feet in dimension. As this is written in the late summer of 1957, I doubt if there are 200 pairs in Chatham County, and the small colonies under observation have not been successful in rearing replacements for the aging birds. About one-half of the possible tern habitat in the County was covered by me in April, May, and June, and trips were also made into portions of Sapelo Sound, and throughout the Altamaha Sound, farther south along the Georgia coast. Everywhere I have been the tale is the same, a few nonbreeders and a few small colonies of nesting birds.

In those early days on Oysterbed, there were some low dunes with an abundant population of *Rattus rattus*, all of the color phase we knew as the roof rat, and many house mice (*Mus musculus*). We never found definite evidence of predation on the terns or their neighbors, the Black Skimmers (*Rynchops nigra*) and the Wilson's Plovers. The chicken snake (*Elaphe obsoleta*) was also present, but no visible predation was noticed. The island was sufficiently isolated so that the mink (*Mustela vison*) and the raccoon (*Procyon lotor*) did not readily reach it. Avian predators were not greatly different from those today.

Oysterbed was built up by the dredging of spoil from the nearby channel, and, if left alone, vegetation soon made it untenable for the terns, skimmers and plovers, but the deposit of fresh sand renewed the habitat. About 1930 a hydraulic fill about three miles long was completed connecting Oysterbed with Jones Island, an 800-acre island to the westward which was largely salt marsh. This furnished a highway for numerous raccoons and minks which prowled the fill to and from the island nightly. Meanwhile, vegetation tended to extinguish the habitat. The birds took up habitation on clear ground at various points on the fill and appeared quite successful for several years, though there are no data on the number of young birds that reached the flying stage. In the

following years harbor improvements created barren sand heaps at various places along the harbor, and the terns and plovers moved sparingly onto these grounds. Small colonies of terns became established inland for about 20 miles, a few plovers nested as far as 15 miles from the Entrance, but the skimmers did not accept nesting grounds beyond the inner end of the fill.

The Mississippi Valley race (*Sterna albifrons athalassos*) nests on sandbars north to Sioux City, Iowa (DuMont, 1934), but our coastal race does not follow the river into the River Swamp. In recent years I have made several summer trips on the Savannah River from the Fall Line to Savannah, and would have seen the birds if they were present. There are numerous sandbars uncovered during the season of summer low water, and there are small fish near the surface for food.

After some time I became aware that these small tern colonies of 15 to 30 pairs were not very successful in their nesting. Some of the trouble was attributed to the Fish Crow (*Corvus ossifragus*), and it was thought that a small colony did not have an adequate defense, and that the attrition by the daily forays of the crows soon caused abandonment of the site. Many times these small groups of terns selected a site, made nests, and laid a few eggs; then after a little time their numbers began to lessen, and finally the site was deserted. In a colonial species like this, it may be that the mass stimulus of certain numbers is necessary before the birds can reach and maintain the proper emotional state for satisfactory nesting. It is not practical to detail here all of the shifting of populations and population centers from the late 1930's to date, even if adequate data were on hand, but now it seems that the decline started with the breakup of the large group on Oysterbed Island, or possibly a few years later when vegetation on the other side of the river began to inhibit nesting there. The last successful nesting of the skimmers at the Entrance was on Oysterbed in 1949, following the deposit of fresh sand in 1948, though it is not known how many young birds were reared. For the next two summers, 1950 and 1951, the skimmers and some Royal Terns (*Thalasseus maximus*) tried to establish a colony well up along the fill. In late May they assembled and prepared nests, but deserted the site by mid-June. At present I know of no skimmer colony in Chatham County.

Though there is clear evidence of a large decrease in numbers over the past 25 years, it cannot definitely be blamed on raccoon predation. This year one unsuccessful colony, whose eggs usually disappeared within a few days after they were laid, had raccoon tracks everywhere. Of all the vertebrates common to this area, the raccoon is the most probable one to have much effect on the terns where the ternery is close to the marshes. Trapping of fur-bearing animals was more intensive during the depression years, and has been less so

since about 1940, due to the fuller employment of those who would otherwise be trappers.

High tides and heavy squalls may also almost wipe out certain colonies. When a squall drops two or three inches of rain in an hour or so, the sand is easily eroded; eggs are buried or washed away; and even the immediate landmarks that may serve to orient the birds to the individual nests may be changed. Sometimes the terns will dig the sand out from around the partly buried eggs if they are left in place, and resume incubation, but if the eggs are separated by only a few inches, the bird will not roll them together again. Years ago there were small colonies on the outer beaches near the high water line, but these were vulnerable at times of high spring tide or storm tide.

Sprunt and Chamberlain (1949) give a glowing account of the prosperity of the Least Tern in the Charleston area. The finding of several small colonies is not evidence of adequate replacements, and I do not know how valid their account would be today, in the light of the status in Georgia. It probably would have been true some years ago.

When a species of relatively long life is declining in numbers due to poor success in the season of reproduction, the condition may not be noticed for some years. Gilbert R. Rossignol had one return of a banded bird at five years of age, and another at ten years. This is scant information as to longevity, but all that is at hand.

A few single birds are often seen foraging miles from any colony, and sometimes three to six pairs may take up on some suitable location, go through a part of the courtship activities, and perhaps even dig a few nest scrapes; but these are probably nonbreeders, perhaps too immature or for some other reason unable to carry through the full nesting cycle.

Timing of Arrival, Egg-laying.—The time of arrival in spring is quite consistent, about April 18 to 20. Courtship begins immediately, and appears to take about 20 days. The first eggs are usually laid about May 7, and from then on fresh eggs may be found at nearly any time up to about the middle of July. There is no indication of two broods; to my mind, the long period of feeding young (to be described later) precludes that. It appears instead that there is much destruction of eggs from one cause or another, even in a highly successful colony, and that the population consists of pairs of birds in various phases, psychologically and physically, of the regimen of the season of reproduction. It has been stated often that, when the nest or eggs are destroyed in any species, the pair goes back to some prior stage in the seasonal pattern. I have found some nests occupied for a week or more after the eggs disappeared, but in no case have I known fresh eggs to be laid there again.

By the end of July there may remain a few young birds still grounded, but most of them are awing, and the colony may be nearly deserted, the main body

of the terns moving to various beaches, sandbars, beds of dead oyster shell, and the like. The numbers diminish about September 1, and by the middle of the month all are gone. There are a few individual birds to be seen later, yet to my thought these few laggards are of little importance in the general scheme.

Courtship and Mating.—There is little indication of pair-formation when the spring migration occurs, but courtship is initiated soon after, and within a week the members of a pair seem to recognize each other by voice, for a resting female will often take off on hearing the notes of an approaching male. The courting grounds are quite independent of the nesting site, and may be miles away. Unlike the Common (*Sterna hirundo*), Gull-billed (*Gelochelidon nilotica*) and Royal Terns, all of which species are engaged in courtship activities when they pass through here in spring, the Least Tern prefers an elevated place near the river bank, rather than an open beach. An old log near the river, the piling tops of the river dikes, the concrete railing to bridges —these are the favored places. One spring the dredge, which was my office and home, worked close by some permeable dikes with flat-topped wooden pilings. For days the females sat on these pilings, apparently not fishing for themselves, accepting the food brought by the males who often mated with them there after the acceptance of some small fish or shrimp. Often a female would fly from her perch and there would ensue a series of flights, quite like the "fish flights" described by Palmer (1941) in the case of the Common Tern, but I have been unable to assign meaning to many parts that to his view seem significant, such as the "straight position," the "bent position," the "aerial glide," the "parade," and so on, though there is great similarity in his description to what takes place in this species.

Courtship feeding is one of the most significant parts of the courtship and is continued through the incubation period; though the complete ceremony which culminates in copulation and the ritual in general become abbreviated as the pair progresses into the median and later stages of the season of reproduction. Much has been written of courtship feeding, but it seems to me that too little emphasis has been given to the transition from the feeding during courtship to the feeding of the incubating female, and finally the bringing of food to the young brood. The symbolic offering of other objects has been mentioned in the literature, as the offering of sticks by the Black Skimmer (Pettingill, 1937). It is widespread among birds. The Osprey (*Pandion haliaetus*) will bring sticks to its incubating mate, who weaves them into the nest structure which becomes enormous in time. The Blue Jay (*Cyanocitta cristata*) brings nesting material and sits quietly nearby until its mate takes it to use in building the nest. The Herring Gull (*Larus argentatus*) in first winter plumage will pick up and carry around sticks, offering and refusing them to others in the flock. Perhaps the small bits of shell that ring the nest

of the Least Tern are such symbolic offerings. When the male brings a fish it may be passed back and forth between the pair a time or so before it is eaten.

The female signifies her readiness to mate by crouching and quivering her wings. The male stands beside or a little behind and turns his head rapidly to right and left for some time. The female also turns her head from right to left but not as much as the male. After mounting the female, the male continues the head-turning for a little time before copulation. The ceremony is distinctive, and has been seen many times.

Fig. 1. Male Least Tern carrying food to incubating female.

Incubation and Eggs.—The birds of the pair have been seen to relieve each other in incubating the eggs, yet it would not do to postulate equal sharing of this duty—if one may apply such a word—when the furnishing of a greater part of the food by the male in courtship, and probably later on, is considered. Certainly the male brings much of the food during some of the incubation period (Fig. 1). It can readily be observed in any colony at this time.

The eggs (size, color, etc.) have been well described in the standard works, and here it can only be pointed out that there is great variation in color, size of spots, etc., within the clutch of eggs. Some lack any warmth of color, others possess much of it. The downy young in the nest exhibit the same variation, some nearly pure gray and white, others with much reddish or brown in the coloration. It had been planned to photograph some variant sets in color, then follow through when the chicks were hatched to see if egg color and that of the downy plumage were related, but the lack of success of the 1956 season prevented this.

The habit of the incubating bird of leaving the nest, flying out over the water and plunging, then returning to shake off the water drops on the eggs, has been discussed elsewhere (Tomkins, 1942). Murbarger (1956) reported the same behavior in the White Pelican (*Pelecanus erythrorhynchos*). The loss of water from the eggs by evaporation might be considerable in very dry times. I have seen the American Oystercatcher (*Haematopus palliatus*) stand beside the nest and not cover the eggs in rain.

Foods and Feeding.—One habitat requirement is an ample supply of small fish or shrimp that swim close to the surface, for this species does not dive

Fig. 2. Least Tern bringing one fish to feed young.

deep nor accept large fishes. Though many thousands have been seen carrying food, it is doubtful if any of the fish have been much over 60 mm. long. When the large colony was nesting on Oysterbed Island, individual birds had a maximum range of 16,000 feet from which they carried food to the colony, though the food nearby was ample and daily replenished by the tides. The terns carry only one fish at a time (Fig. 2), mostly small slim fish of several species, and it must take a lot of flying, even at a median distance of one and a half miles, to satisfy the growing young (Fig. 3). On the other hand the Black Skimmer often feeds to the young fish or shrimp that are too long for the alimentary canal, and it is common to find a young bird with the tail of a fish sticking out of its mouth.

Though the Least Tern will now and then swoop down to the water surface and pick up a small fish between its mandibles, the normal way is to close the mandibles and spear the fish. Many of the fish discarded in the colony show punctures midway. Some years ago a Caspian Tern (*Hydroprogne caspia*) (Tomkins, 1934) was found with its mandibles stuck in the top of an old piling that was submerged at high tide. The mandibles were closed. Evidently

the tern had plunged at a fish, stuck its mandibles into the piling top and drowned. Plunging in the tern manner is sometimes indulged in by Bonaparte's Gull (*Larus philadelphia*), normally a dabbler, so the method of feeding is not confined to the terns.

FIG. 3. Least Tern 2½–3 weeks old; natal down being replaced by juvenal plumage.

Care of Young.—The things observed within the colony have not been enough different from published accounts for similar species to justify much comment. The young are known individually to the parents even though they wander considerably. When the young are able to fly and follow their parents, each adult, accompanied by one young bird, flies out over the water, plunges and catches a fish, then alights on the water and gives it to the young. Adults are still feeding young when they leave Georgia in September. When the young begin to feed for themselves is unknown. Both the Caspian and Royal Terns, neither of which nests in our immediate locality in any numbers, continue to catch food for the young until about November. These two species and the Least Tern frequently lay three eggs. Why then should one never see an adult followed by more than one young? At this stage the family does not seem to exist as such, but is separated into components of one adult and one young. One might assume that each adult cares for one individual young bird, and for that alone, but is this true? I have no answer at hand.

Even though the young birds, when fully fledged and competent in flight (Fig. 4), do not catch their own food for some time, there seems to be an inherited diving pattern. One day I came by a small borrow pit filled with

water about one foot deep, near a tern colony, and found a young Least Tern repeatedly diving into the pool. The pool had been made recently and had no tidal connection. It had been checked for small fish a couple of times recently. There was no sign that this bird was trying to catch fish, nor did it catch any

FIG. 4. Least Tern in juvenal plumage, able to fly.

while I watched the whole performance. The diving seemed to be play or practice, and at any rate it seemed to satisfy some inherent need in the young bird.

Palmer (1941:92), in his study of the Common Tern, has found such similarity in the feeding of the young when they are able to fly, that it deserves full quotation here: "Soon however, the juvenal begins to follow the parent on fishing trips. When following, it utters a high-pitched *ki-ki-ki-ki* and the adult responds with a *ki* or *kip* or *ke*, this last being a modified first part of the *ke-arr* of alarm. Chick and parent alternate rapidly in this calling. I have not been able to observe the transition from the stage of following the parents to the time when the young fish independently. Probably the Juvenals, which spend some time flying by themselves, sight fish in the water and instinctively dive for it.

"Prior to September 5, 1939, when I left the vicinity of the terneries, I had not seen a single juvenal catch a fish. . . ."

Summary

The Least Tern arrives at the Savannah River Entrance, Georgia, in late April, nests and rears young, and leaves in early September.

Twenty-five to 30 years ago the species was numerous. Its numbers are now reduced to about 5 to 8 per cent of its former numbers, and recent nestings have not been very successful.

The reason may be a reduction of predator-free nesting grounds, but it is not certain.

The courtship and nesting habits are discussed briefly.

Literature Cited

DuMont, P. A.
1934 A revised list of the birds of Iowa. Univ. Iowa Studies. Vol. 15, pt. 5.

Erichsen, W. J.
1921 Notes on the habits of the breeding water birds of Chatham County, Georgia. *Wilson Bull.*, 33:69–82.

Murbarger, N.
1956 The birds of Anaho. *Nat. Hist.*, 65:300–305.

Palmer, R. S.
1941 A behavior study of the Common Tern. *Proc. Boston Soc. Nat. Hist.*, 42 (1).

Pettingill, O. S., Jr.
1937 Behavior of Black Skimmers at Cardwell Island, Virginia. *Auk*, 54:237–244.

Sprunt, A., Jr., and E. B. Chamberlain
1949 South Carolina bird life. Univ. South Carolina Press, Columbia, 585 pp.

Tomkins, I. R.
1934 A curious tern accident. *Wilson Bull.*, 45:128.
1942 Least Tern watering eggs; Gideon Mabbett's query. *Auk*, 59:308.

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EARLY REPRODUCTIVE BEHAVIOR OF FLICKERS

BY LAWRENCE KILHAM

The purpose of this paper is to record observations on the reproductive behavior of Yellow-shafted Flickers (*Colaptes auratus*) in the early breeding season, both in the field and in an indoor aviary. Some field observations were made at the Archbold Biological Station, Lake Placid, Florida, in February and April, and at Tamworth, New Hampshire, in May of 1958. Year-around observations on flickers have been made in Seneca and Bethesda, Maryland. I have spent approximately 500 hours a year for three years studying the comparative behavior of woodpeckers.

The early breeding season of flickers extends from the time of pair formation to the time of establishment of a nest hole just prior to egg-laying, a period which may last for three months. Bent (1939) and Burns (1900), among others, have described the general natural history of flickers. Descriptions are lacking, however, of tapping, duets of drumming, and even of the various methods of communication in relation to attendant circumstances.

Methods of Communication

Flickers communicate by dancing, by drumming, by varied vocalizations, and also by tapping, which, as described for Red-bellied Woodpeckers (*Centurus carolinus*), takes place in the early breeding season (Kilham, 1958). Methods of expression may be used with varying intensity and in assorted combinations, depending upon the situations involved. The following forms are distinguishable:

Vocalizations.—

(a) High call.—A loud *kick, kick, kick* of great carrying power, which, at less intensity, sounds like *wick-a-wick-a-wick.*

(b) Dance calls.—The dances of flickers may be accompanied by *we-cup*'s or by soft *chewki*'s, the latter note appearing to be the more intimate one.

(c) Intimate notes.—Notes exchanged by mated flickers are numerous, particularly near the time of coition. Common varieties are *oi-eek, oi-eek,* and *werp, werp* or *what, what,* all of which suggest the low, conversational notes of Blue Jays (*Cyanocitta cristata*).

(d) Alarm call.—*Keogh.*

Dance display.—Flickers dance at full intensity by spreading and uptilting their tails to one side, thus displaying the yellow underside, by raising their red nuchal patches and, concomitantly, swinging and bowing their bodies from side to side as their bills jerk up and down in a W- or a figure-8-shaped course. Many forms of dancing are possible in a range between these extremes, and Noble (1936) has given further description.

Drumming.—The drumming of flickers is like a miniature pneumatic drill, for the individual blows come at a rapid, even rate from start to finish. Each burst lasts for about one second. Pauses between drummings may be anywhere from 10 to 40 seconds or longer, and male and female flickers may drum together, first one, then the other, in an alternating duet.

Tapping.—Flickers tap at a slow, countable rate of two to three taps per second and in bursts of two to 20 or more taps. There is usually a slight pause between bursts. One can learn to recognize tapping at a distance of several hundred yards. I have found no essential difference between the tapping of flickers and that of Red-bellied and Red-headed Woodpeckers (*Melanerpes erythrocephalus*) except that both sexes of the latter two species may tap simultaneously in what I have termed "mutual tapping" (Kilham, 1958 and 1959). Male and female flickers tap at separate times. Tapping for all of these species is associated, predominantly, with selection of a site for a nest hole.

Wing noise.—Flickers may make a *wurrp* noise with their wings when flying, even for a few feet. This noise is one of alarm and is not infrequently associated with the vocalization, *keogh.* Many species of woodpeckers can make ruffle noises with their wings, but the *wurrp* of flickers is unusual in being somewhat musical.

Bill-touching.—My hand-raised flickers occasionally touched or seized each other's bill-tips, often protruding their tongues at the same time. I have not observed bill-touching in the field. Althea Sherman (1910:142) stated that in years of close study of this species she had "never seen anything that suggested the feeding of one mate by the other," and doubted very much if this is done. One wonders, however, whether bill-touching may not represent the courtship feeding of other species. Flickers do not bring visible food, but pump or regurgitate into the open bill of the young one, which seizes the bill of its parent as Sherman has well described. Bill-touching may be symbolic of this manner of feeding. According to Tanner (1942), Ivory-billed Woodpeckers (*Campephilus principalis*) may touch bills in courtship, and Allen (1937:168) wrote that as a female climbed up a pine toward her mate "he bent his head downward and clasped bills with her."

Field Observations

The field observations given below have been selected from many others as contributing to an understanding of the flickers which bred in captivity. These observations fall under three headings:

Pair formation.—The displays and vocalizations of flickers may vary in intensity depending upon whether two of the same sex, or three birds representing both sexes are participating. The following observations were made in mid-winter, in a Florida pasture, before any search for a nest hole was evident.

(a) Dance of males.—A male flicker alit on a pine tree about 8:30 a.m. on February 2. He called *we-cup*, gave an abbreviated high call, then rested a moment before flying to the ground. A second male, equally unhurried, alit in the same grassy opening and the two flickers now faced each other, about four inches apart. About every 15 seconds they would point their bills into the air and wave them about for four or five seconds, exposing their throats and black moustaches in the process (Fig. 1). These odd dances went on in silence for six or seven minutes. The flickers then hopped along to a new opening among the saw-palmettoes (*Serenoa*) for another few minutes of the same performance. They kept wings and tails closed. Both birds finally flew into different trees, and the dances, which may have been between rivals for domination of one section of the pasture, ended without physical conflict.

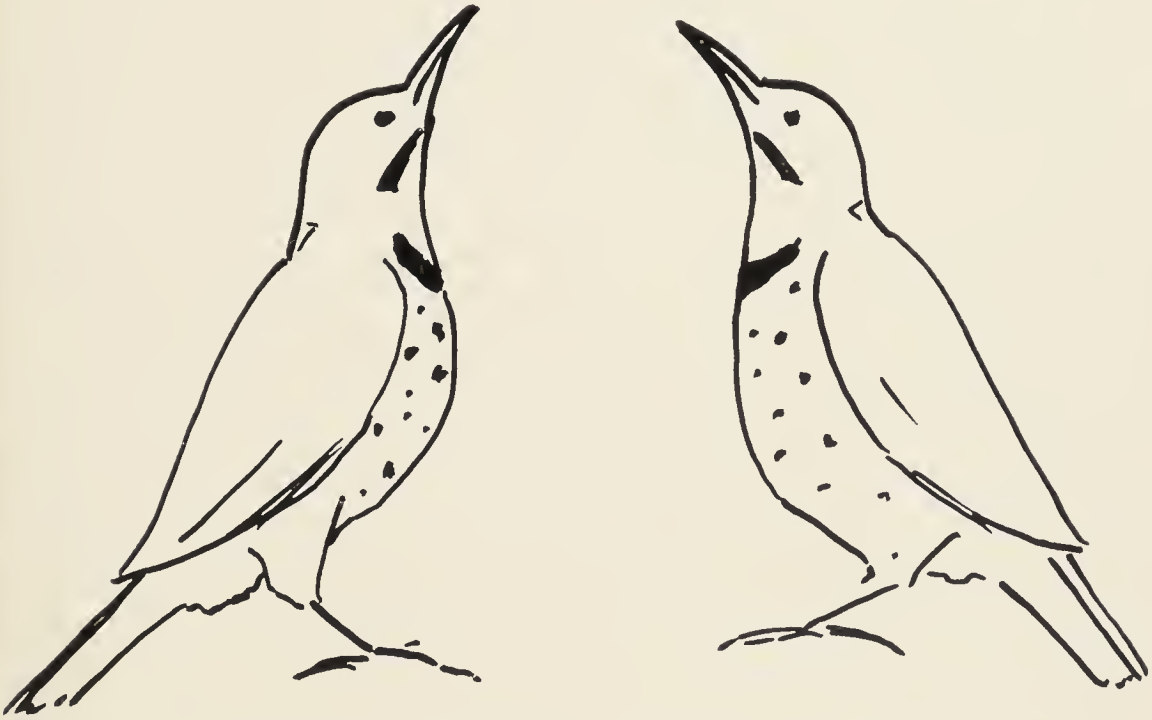

FIG. 1. Silent dance of two male flickers, Florida pasture, February 2, 1958.

(b) Dance of a male and two rival females.—Frost lay on the ground three days later when, at 7:30 a.m., I heard a medley of *we-cup*'s coming from the corner of the pasture where the males had displayed. There were now three flickers, a male and two females. They were all clinging to the trunk of a pine tree and would occasionally join in bursts of bill-waving to the accompaniment of low *we-cup*'s. The male was the least interested. He finally flew to a dead stub where he drummed and gave his high call. The two females quieted down as soon as he had left. Their vocalizations were now *chewki, chewki*, and their bill-waving became rather mild. They soon flew away. The trio reassembled shortly afterward on a dead pine limb where the male was perched on an elbow with the two females flanking him. Dances lasting four or five seconds alternated with periods of quiescence lasting 30 seconds. These dances were at full intensity. All three birds waved their bills, called a shrill *we-cup, we-cup*, raised their red crests and displayed much yellow by partly spreading their wings while fanning and uptilting their tails. The male tried to drum between dances. The females, however, gave him no respite, for they would

start a new dance which, to all appearances, he seemed compelled to join. Affairs continued in this fashion for five minutes. The tempo was gradually decreasing when one of the females suddenly flew at the male, driving him from his perch. This attack aroused excitement all around. The *we-cup*'s were again shrill, and one of the females drummed briefly. A second attack maintained the excitement. This time the aggressive female struck the male as if attempting to alight on his back and the two fell grappling to the ground. The male flicker then flew away. In his absence the two females reverted to a mild bill-waving accompanied by low *chewki*'s and *we-cup*'s. Variations of these performances went on for 1¼ hours.

Search for a nest hole.—

(a) Prolonged communication.—At mid-morning on April 30, a pair of flickers was on the dead pine where the trio had danced on February 5. Their activities over the next hour were as follows: The male was giving full dances. His mate kept bowing her head but was apparently less excited than he was, although both called *we-cup*. She departed on a long flight down the pasture fence. He remained on the dead pine, drumming about once a minute and giving occasional high calls. His mate, in spite of being 250 yards away, joined in with drummings and high calls of her own, as if communicating with him. He made two moves in her direction (Fig. 2) and continued his part of the duet. What looked like an impasse was broken when I chanced to see her returning, first to a pine 60 feet away, then to one adjacent to her mate. He stopped calling. There were no more vocalizations from either bird for 30 minutes, during which time he drummed alone until she broke a 20-minute silence by joining him in the drumming. The duet had no synchronization. Each individual gave a burst about once every 40 seconds. A man piling boards finally frightened the pair away. Events which took place two days later suggested that the long communication of the two flickers had involved possible sites for a nest hole.

(b) Agreement on the female's choice of nest hole.—On May 2 I heard tapping near the tree where the male had drummed in the long communication two days previously. I then spotted the male flicker as he tapped 12 bursts of eight to 12 taps each, just above a shallow, weathered excavation. His mate was on a limb above. When he left, she flew down and inspected the site. She did not tap. At 6:45 a.m., a half-hour later, I found the female calling once more from the pine stub down along the fence from which she had responded in the communication of two days before (Fig. 2). She now entered a hole in the stub, turned around and looked out for five minutes. Then she withdrew and tapped just inside the entrance, where I could see her bill as she gave two bursts of four taps each. The male had reached the entrance by the second burst, his crest raised and tail outspread as he made soft *chewki* notes. She slipped out, brushing past his neck. He now entered and appeared to tap inside. By the intensity with which he excavated the hole, already hollowed in some previous year, and by the coition described below, I presumed that this site had been finally agreed upon. He would appear at the entrance every so often to throw out a bill full of sawdust, sometimes repeating this performance ten or 15 times in succession.

(c) Removal of debris.—The male flicker emerged from the hole in the midst of his excavating with a half-inch piece of debris and, instead of dropping it out of the entrance as flickers may do with larger objects, flew off with it, holding his head high in an awkward fashion. He dropped the debris by an adjacent tree, then wiped his bill. A few minutes later he was again throwing out sawdust when he stopped to carry another piece of debris away from the hole. I had already observed the same phenomenon a number of times with the hand-raised male in the aviary. My conjecture was that, in both cases, a proper-sized object had stimulated the males to perform a piece of parental behavior, for

their awkward manner of flight suggested that of a male flicker leaving the nest with a fecal sack after feeding its young, a form of behavior which I had witnessed.

(d) Coition.—The male had been excavating for an hour when his mate returned, giving a soft *wrr, wrr* note as she alit at the entrance. She showed no interest in excavating on this or later visits. At 9:25 a.m. she had entered and was looking outward when her mate called *we-cup*, and shortly afterward gave a high call from a dead pine 80 feet away. She responded with a low *wick-a-wick*, then flew to him and crouched low on a limb where he mounted her in full coition.

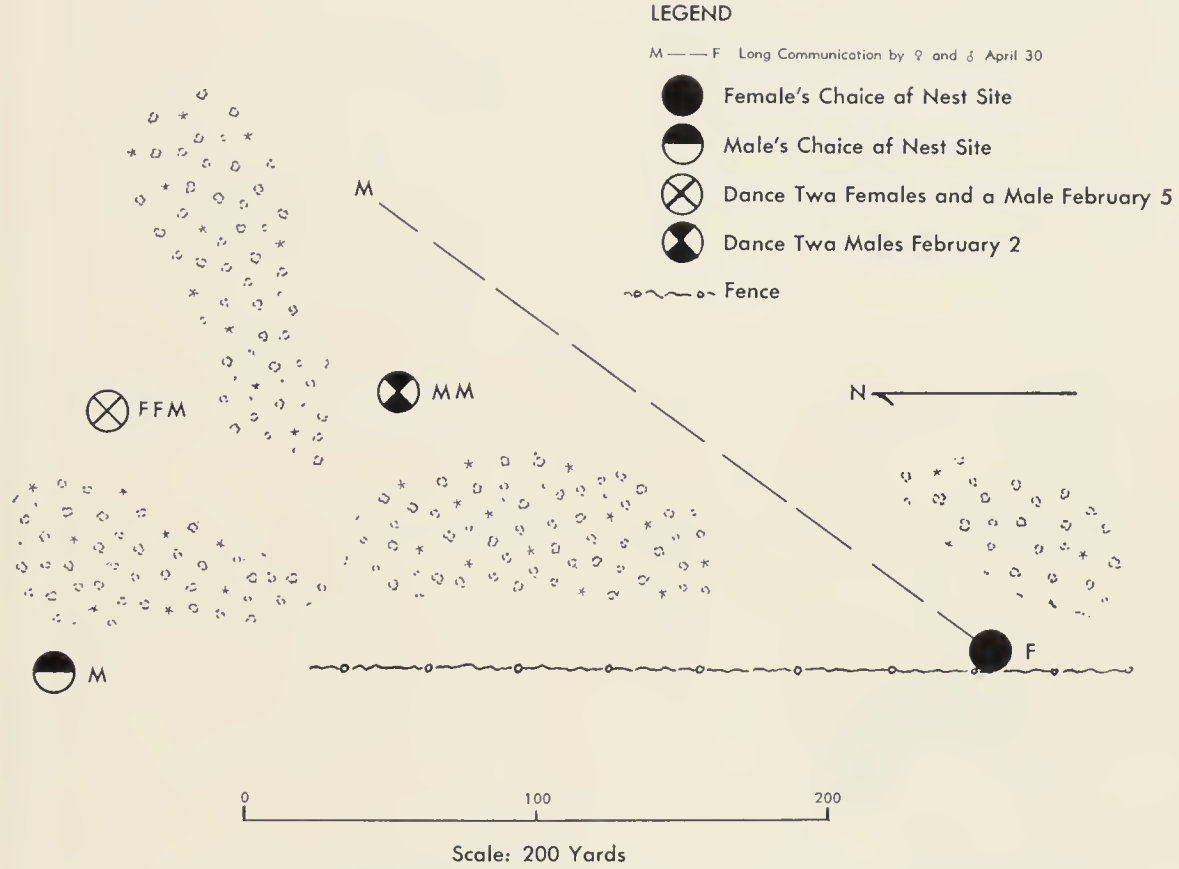

Fig. 2. The Florida pasture. Diagram of the events in the early breeding behavior of a pair of flickers, including conflicts associated with pair formation and a distance communication between the male and female over the site of a nest hole.

Excavation and tapping.—A pair of flickers was excavating a hole just below a limb, 50 feet up in a dead white pine in a woods at Tamworth, New Hampshire, May 18, 1958. I saw the female alight and tap seven or eight times, about six inches above the hole. Her mate flew over, danced on a limb below and gave *chewki* notes. This behavior was different from what I had observed among Red-bellied Woodpeckers, where the male almost invariably initiates the tapping and is frequently joined by his mate (Kilham, 1958). Since dawn is a particularly favorable time to observe the mutual tapping of these woodpeckers, I came on two mornings to see what the flickers might do at this time of day. Events on May 21 were representative. The male had gone to roost in his new excavation on the night of May 20, and he was looking out from the entrance when I approached at dawn. At 5:14 a.m. he emerged to give drummings and high calls from a neighboring dead

pine. He soon returned to rest by his excavation, and I then heard an abbreviated high call as the female approached. The male responded with a full high call. He now moved down to the hole, tapped three bursts of 15, eight, and two taps and then, when his mate alit on a limb above, joined her in a brief dance without vocalizations. I have never witnessed mutual tapping among flickers.

Development of Breeding Behavior in Captivity

Two nestling flickers, about three weeks of age, were removed from their nest hole in Bethesda, Maryland, on July 7, 1957, and kept in an indoor garage, modified into an aviary ten and a half feet square and seven and a half feet high. This pair mated and incubated five fertile eggs the following spring. It was apparent from field observations that the vocalizations and behavior of my hand-raised birds differed in no essential way from those of wild flickers observed in Florida, Maryland, and New Hampshire. One presumes that much of flicker behavior is either innate or is learned prior to leaving the nest.

The two young flickers carried on some phases of breeding behavior in a fragmentary way, but with increasing skill, from the time they were nestlings. Their activities may be outlined as follows:

Juvenile development.—The two fledglings might have left their nest naturally on July 11. On this day the female waved head and body, called *we-cup*, then seized her brother's bill in her own. I witnessed no further bill-touching (Fig. 3A) until December. The flickers were comparatively quiet during July and August but, when approaching each other, they might dance like mechanical puppets and call *we-cup*. They did little drumming in August and the male gave his first high call at the end of the month. A post-juvenal molt was now underway. The female had lost her black moustache by September 9, and both birds had bright yellow under their wings and tails. Their reactions to each other became of increasing interest.

Association and dominance.—The male gave occasional high calls during fall months and usually danced and called *chewki* when coming near the female, whose behavior remained subdued. Both flickers drummed. The bursts might start in a slow way before reaching the pneumatic intensity which became habitual later on. It was evident that the two birds liked to be together, for if he flew to the ground, she might follow and both would toss leaves and soil about with a vigorous prying motion of their bills, within a few inches of each other. His dominance was particularly manifest at feeding places. If he found a good spot, he would give a *we-cup* dance as she approached and she would leave, but if she turned up something of interest, such as an earthworm, he might displace her quietly. This situation continued through the breeding season. There were occasions, however, when the female might display vigorously, and one was when I used a hose to water the earth,

FIG. 3. Some events characterizing the early reproductive behavior of flickers. (A, above) Bill-touching. (B, left) Male at entrance to nest box "swells" upward toward mate who is doing a *chewki* dance on roof. (C, right) Male removing large piece of debris from nest box.

logs and plants in the aviary. The male was much alarmed by this procedure. On September 18 and October 16, he ran about the bottom of the aviary in a furtive manner for some hours, during which time the female assumed a dominant behavior, dancing at full intensity and calling *we-cup*. She appeared stimulated by his submissiveness. This fortuitious experiment suggested that the male's usual activity in dances and vocalizations was a means of maintaining dominance. When he stopped, she assumed the role. The normal male dominance appeared to be important to subsequent breeding, for such problems as which bird should spend the night in the nest hole were solved automatically by the male taking over.

Pair formation.—Wild flickers, observed during the autumn in a swamp near Seneca, Maryland, behaved much like my captive flickers in displaying fragments of breeding behavior. The swamp flickers were migrants. When winter weather led to a cessation of their incipient breeding activities, my captive birds, living indoors, continued to develop. I suspected that something approaching actual pair formation took place in early December. The female became more assertive and this seemed to stimulate the male. On December 10, for example, she was taking much of the initiative, and after a *chewki* dance at full intensity, the two birds seized each other's bills. The female then drummed. She had done little drumming in previous months. The male drummed regularly on an upright ash log, and on January 2 his mate settled two feet below him for an alternating duet. They had many such duets in following months.

Phases of Breeding Behavior

New types of behavior appeared when I placed a nest box in the aviary on March 9. The male kept putting head and shoulders inside to inspect the hole and did the first tapping which we had seen. He continued to tap above the entrance almost daily. The female did not start tapping until March 21, but three days later she gave 50 taps in three consecutive bursts. High calls and dances indicated increasing excitement. I realized by March 25, however, that the nest box was too small, and I replaced it with a larger one. The first egg was laid on May 23. Two cycles were to reach a crescendo, then collapse, before I realized that (1) the box had to be on a pole away from the wall and (2) an aggressive male sapsucker, also paired and trying to breed, had to be removed. Field observations suggested that such phases are not unnatural. Woodpeckers may experience various difficulties and defeats before finding a suitable nest hole, as I have described for one pair of Red-bellied Woodpeckers (Kilham, 1958). There was an interplay of interest between the two flickers. The male would have the greatest interest at the start of a cycle and periods of intense excitement might follow as he roused his mate to an

enthusiasm for the potential nest hole. Her interest would finally collapse in abortive cycles, to his obvious distress. I would then re-locate the nest box. The flickers went on to repeated coition and egg-laying when my last efforts produced a suitable arrangement. The activities involved in a typical cycle may be outlined as follows:

Efforts of male to win female to nest box.—

(a) Entry to box.—The male went completely inside the new nest box from the day it was installed, but the female, for some days, did no more than cling to the entrance and look in. Either bird might hang from the entrance by one foot to sound the outside of the cavity with a few pecks or explore it with its long tongue.

(b) Tapping.—While both sexes tapped above the entrance on the first day, the male did most of the early tapping and was the first to tap from the inside. On April 14, for example, he tapped three bursts of 14, 20, and three taps, respectively, on the outside. He later tapped ten bursts on the inside. One could see his head moving just within the entrance and I counted 33 taps in one of the bursts.

(c) Response of female to tapping of male.—The more common responses of the female to the tapping of her mate were (1) to drum or (2) to give a high call. (3) She sometimes answered with soft notes such as *what, what* and (4) she might fly to the roof for a *chewki* dance while the male was below at the entrance (Fig. 3B). (5) Finally, the female might fly to the entrance when he had tapped from the inside and the two would face each other, he sinking low while her head was high.

(d) Female follows male.—She would follow male persistently, soon joining him wherever he might alight, and often initiating dancing.

(e) Other activities.—Duets of drumming, occasional bill-touching and shrill *we-cup*'s continued in a random fashion. The loud, persistent high calls of male flickers are one of their best-known activities in nature. My captive birds gave relatively few high calls. By one interpretation, the caged birds were already paired and the male had, in consequence, no need to call up a mate.

Rising acquiescence of female.—Two weeks after I had installed a new nest box activities became very intense. The female started performing much of what her mate had been doing and he started new forms of behavior.

(a) Male and female in box together.—The female now began to enter the box for the first time and soon both flickers went into the nest together. She usually came out first. If she happened to be inside and he looked in, she might squeeze out past his neck.

(b) Male removes sawdust from box.—When the female started taking a greater interest, her mate began removing some of the sawdust which I had placed in the bottom of the box. Instead of tossing it out of the entrance as excavating flickers usually do (*vide supra*) he might carry up to five billfuls across the aviary and deposit them (Fig. 3C). His manner of holding his head high was suggestive of a parent flicker flying off with a fecal sack. Since the nest box was fully excavated to begin with, sawdust removal appeared to be a ceremony or rehearsal of events to come.

(c) Tapping.—The female began to tap more on the outside of the box, and the male to tap at the bottom of it, so that we could no longer see his head moving.

(d) Male seizes female.—When the two flickers were in the box together, the male might seize his mate as she started to wriggle out. One could see small feathers clinging to his bill afterward and I noticed an increasing number of them about the aviary.

(e) Swelling upward at entrance.—If the male tapped while at the outside of the hole, the female might alight on the roof and bend downward in a *chewki* dance. The male

would raise his red nuchal patch, then swell upward toward her without moving his feet from the lower rim of the hole. At a later time, when she had begun tapping more frequently, she would swell upward toward him in similar fashion or, if he only came near the box, she might swell sideways with her breast toward him.

(f) Female swoops on male.—When the male was at the entrance or was feeding on the ground, his mate might swoop down in flight as if to peck him.

(g) Soft notes by female.—The female made an increasing number of soft notes, such as, *what, what* and *oi-eek, oieek* as the activities of the pair were becoming increasingly quiet.

(h) Male seeks coition.—The male would come along beside the female in a manner not observed previously. He behaved as if trying to mount, but she would move away.

(i) Other activities.—There was occasional bill-touching and a decline of drumming in the late part of the cycle.

Collapse of female interest.—The female lost interest toward the end of each of the first three cycles of breeding behavior which took place between March 9 and May 4. The male reversed roles and pursued her when she no longer came to the box. A fourth and successful cycle began on May 4.

Full acceptance of nest hole by female.—As indicated by the behavior described below, the female quickly accepted the nest box when I hung it on a pole and removed the male sapsucker from the aviary.

(a) Extensive tapping by female.—On May 5, in the final cycle, the female tapped ten bursts of six to eight taps each when she was inside the nest box. Her head was just showing. She later tapped out of sight at the bottom of the box in the manner of her mate's earlier behavior.

(b) Female by box more than male.—She spent increasing amounts of time clinging to the entrance hole or quietly disappearing inside. Her mate might look in briefly, then leave.

(c) Female invites coition.—The pair was often on the ground feeding when she would fly up making soft *oik*'s to crouch on a limb by the window. He would follow immediately. Full coition took place on some occasions and pseudo-coition at others. In full coition, the male would fly to the female when she had assumed the inviting pose, mount her back, then take time to get well established. He would peck down at her bill, meanwhile falling off to her left side and somewhat backward as cloacal contact took place. We might observe coitions three or four times a day, but they were undoubtedly more frequent. They might take place at any hour. The final breeding phase began on May 4, coition was first observed on May 7, the first egg was laid on May 23, and full coition was last observed on May 27. A fifth egg was laid on May 29.

(d) Female attacks male.—The aggressiveness of the female came as a marked change from her earlier subdued manner. When she was in the box, she might draw back and strike at her mate when he came to the entrance. She also did this at a later time when brooding eggs.

(e) Increasing quiet.—There were few noises compared with previous weeks. Drummings and high calls were infrequent, but the pair did exchange soft, low notes.

Laying and incubation of eggs.—It was evident when the female had laid her first egg, for she filled the whole entrance by puffing out her breast feathers and drawing her head back as if ready to strike. She struck at my hand savagely when in the same pose four days later. This was unusual boldness, for she had always been shy.

(a) Eating of eggshell.—When a hen's eggshell was placed in the aviary on May 27,

the male immediately explored the fragments with his tongue and left. His mate then flew down and devoured the pieces eagerly.

(b) Nest relief and tapping.—The female came to the entrance, making soft notes, at 7 a.m. on May 27. Her mate tapped briefly from the bottom of the nest, then slipped out of the entrance. She entered thereafter. A similar episode took place on the following day, only he remained where he was.

(c) Male spends night in nest hole.—The male did not spend any nights within holes from the time I first got him in July until May 29 of the next year when the last egg had been laid. He then spent every night in the hole until June 5.

Final collapse.—I finally decided not to attempt any full nesting of the flickers, since we were about to go on leave, and early breeding behavior had been the principle object of the study. The female flicker lost all interest in incubation when I re-introduced the male sapsucker. Her mate persisted longer but was much disturbed at not being relieved at the nest, and the two dramatic events which took place possibly resulted from his frustration.

(a) Savage attack by male.—The female was attacked by the sapsucker early on the morning of May 30 and was too frightened to come to the nest. Her mate waited for her a long time. He finally came out and began a relentless attack, driving her back and forth across the aviary to the point of exhaustion. He then alit on her body and pecked at her head. She only escaped by crawling into a hollow log from which I pulled her some hours later. I removed the sapsucker to give her a respite, and she recovered sufficiently to resume incubation late in the afternoon.

(b) Male destroys eggs.—Both flickers had lost interest by June 5 and were feeding together in the afternoon. After a half hour of quiet activities, the male suddenly went wild. Apparently there was no immediate cause for this explosive behavior consisting of a mixture of high calls, drummings and *we-cup* dances before his mate, interspersed with frantic flying to and fro. She followed him about but remained calm. The male now went to the nest and emerged with an egg which he deposited on the ground. He then carried out three more eggs, all of which oozed blood from punctures and contained embryos. The fifth egg was punctured but not removed. After this episode the pair became as peaceful as before.

Displays Against Territorial Rivals

On February 22, 1959, I put the pair of hand-raised flickers into a large cage on the outside of the house. Within a few hours a pair of wild flickers was displaying on the outside of the wire. The yard resounded with high calls and drummings. Both wild birds would fly to the wire with outspread wings and tails displaying the full yellow as male postured opposite male and female against female. This sex alignment was an invariable pattern. The displays continued vigorously throughout the next day in spite of rain and with some lessening of activity for the next three weeks until I returned the captive birds to the aviary. The wild female flicker (WF) was the most persistent. She would run around the edge of the wire, tilting way over in constant *we-cup* and *chewki* dances, following the tame female (TF) wherever the latter moved. TF responded with similar dances. WF sometimes drummed loudly on a tin gutter above the cage or gave high calls from adjacent trees. The wild male

carried on in the same manner as his mate. He was less interested, however, and would fly away after a shorter time. The tame male did not pay much attention to him.

This experiment with an outdoor cage had interest from three points of view: (1) the wild flickers were apparently paired and ready to defend a territory in late winter; (2) in territorial conflicts male displayed against male and female against female; and (3) the displays, vocalizations and drummings used in these conflicts were much the same as those observed during courtship.

Discussion

The Green Woodpecker (*Picus viridis*) resembles the flicker in feeding on the ground and in having a long protrusible tongue. Blume (1955) made observations on a pair of these birds in May. The male and female communicated with each other over a distance of 500 meters in a "*Rufkorrespondenz*" which continued for a long time, the female calling from the vicinity of the subsequent nest tree. Blume believed that she chose the final site. Thus in the long communication which Blume described for May 1, as in the one which I observed in Florida on April 30, the female was trying to attract the male from his preference for a nest site to hers, or so it appeared, for in each case the female's choice was the one finally accepted.

Woodpecker behavior is open to varied interpretation. Noble (1936:279), after observing and experimenting with a pair of flickers over a few weeks in the breeding season, concluded that the dance of the flickers was "in no sense a method of attracting or stimulating individuals of the opposite sex, but rather a means of defending territory and driving off rivals." This statement represents a limited interpretation. My captive flickers, for example, danced the year around in a complete absence of specific rivals. I have concluded from field and aviary studies that the dance displays, like many of the vocalizations, drummings and tappings made by flickers, are usually made to attract or stimulate individuals of the opposite sex. Flickers, like other woodpeckers, are most expressive in the early breeding season. More studies will be needed before one can fully interpret their behavior.

Summary

1. The early breeding behavior of flickers has been studied in the field and in an aviary where a hand-raised pair mated and laid fertile eggs.

2. Methods of communication include drumming, tapping, dance displays, wing noise, bill-touching and vocalizations. The last method is categorized into high calls, dance calls, intimate notes and alarm call.

3. Field observations:

(a) Pair formation appeared to take place in mid-winter without reference to a potential nest hole.

(b) A conflict of males at this time was limited to movements of heads and bills, without vocalizations or physical contact.

(c) The most intense displays and vocalizations arose when two females competed for a male. One female attacked the male several times.

(d) In the course of a search for a nest hole in April, a pair of flickers communicated with each other by dances and *we-cup*'s, then by a long distance communication of drums and high calls, and finally, on rejoining, by a duet of drumming. The female's choice of a nest hole was the one accepted by the pair.

(e) Male and female flickers tap in the same manner but not at the same time; the tapping is done in relation to potential nest holes or to ones being excavated.

4. A pair of captive flickers experienced four phases of breeding in which the female evidenced increasing acceptance of the nest box as the male took the lead in arousing her interest. After three failures in which the female's interest collapsed, the box was finally located in a favorable situation and successful mating took place. The interplay of behavior between the two sexes went through the following stages:

(a) Breeding behavior was precipitated when a nest box was placed in the aviary on March 9.

(b) The male was always the first to enter the box in each location, to tap on the outside by the entrance and, later, on the inside. His mate would carry through the same performances after a delay of some days.

(c) The pair danced together, had duets of drumming and occasionally touched bills at this early stage.

(d) As the female began to accept the nest she spent more time clinging to the entrance, made intimate notes and sometimes entered the nest box with the male.

(e) With this increase of interest by the female, the male began to tap out of sight at the bottom of the nest hole and to remove sawdust.

(f) The excavating male might occasionally carry a piece of debris well away from the nest box, then wipe his bill. This behavior followed the pattern of a parent male flying from the nest with a fecal sack.

(g) With continued increase of the female's interest, the male sought coition, but she was unresponsive, initially.

(h) Once the female had accepted the nest box, she invited coition by crouching low on a limb, many times a day. Full coition would follow if the male was ready. Otherwise he might mount and come off in pseudo-coition.

(i) Vocalizations and displays were minimal at this late stage. The female did a good deal of tapping at the bottom of the nest box and she might strike at the male when he came to the entrance.

(j) As soon as the female had laid her first egg, she began to rest in the entrance with her breast feathers puffed out, ready to strike at any intruder.

(k) The male began spending nights in the nest box after the fifth and last egg was laid.

5. Dances and vocalizations associated with territoriality were demonstrated when a pair of wild flickers displayed against the hand-raised pair, which was kept in an outside cage for three weeks.

Literature Cited

Allen, A. A. and P. P. Kellogg
1937 Recent observations on the Ivory-billed Woodpecker. *Auk*, 54:164–184.

Bent, A. C.
1939 Life histories of North American woodpeckers. *U. S. Nat. Mus. Bull.*, 174:334 pp.

Blume, D.
1955 Uber einige Verhaltensweisen des Grunspechtes in der fortpflanzungszeit. *Vogelwelt*, 76:193–210.

Burns, F. L.
1900 A monograph of the flicker. *Wilson Bull.*, 7:1–82.

Kilham, L.
1958 Pair formation, mutual tapping and nest hole selection of Red-bellied Woodpeckers. *Auk*, 75:318–329.
1959 Mutual tapping of Red-headed Woodpeckers. *Auk*, 76:235–236.

Noble, G. K.
1936 Courtship and sexual selection of the flicker (*Colaptes auratus luteus*). *Auk*, 53:269–282.

Sherman, A. R.
1910 At the sign of the Northern Flicker. *Wilson Bull.*, 17:135–166.

Tanner, J. T.
1942 The Ivory-billed Woodpecker. Res. Rep. No. 1, Nat'l Aud. Soc. N. Y. 111 pp.

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TESTICULAR RESPONSE IN BOBWHITES TO INTERRUPTED DARK PERIODS[1]

BY CHARLES M. KIRKPATRICK

In many photoperiod studies relating to reproduction in birds, the basic technique is the use of light to influence gonadal development and function. In Bobwhites (*Colinus virginianus*), gonadal responses to light are unequal between sexes. Incidental evidence from previous experiments (Kirkpatrick, 1955) indicated that cocks become sexually mature substantially before hens lay, when both have received identical light treatment and management. In quantitative photoperiodicity studies based upon time, intensity, or other variables, it is never implicit that results pertaining to one sex of Bobwhites apply to the other sex. Thus, experiments to test the effects of light upon reproductive response in Bobwhites, and perhaps other species, should be designed accordingly if the desired end point is a mere stimulation of tissues, full spermatogenesis, or ovulation. This paper reports an experiment to determine the time required for Bobwhite cocks to produce mature sperm under certain conditions of lighting, and compares the thresholds of sperm production and egg laying.

Methods

The procedure of the present experiment was to sacrifice cocks after regular intervals of exposure to interrupted dark periods (Kirkpatrick and Leopold, 1952) for an evaluation of testicular development stages. It was not proposed to analyze or describe the minute details of testis histology at the sacrifice intervals, but merely to correlate the intervals with the more obvious aspects of testicular development, namely, weight, tubule expansion, lumina formation, and free spermatozoa. The accepted sign of sexual maturity in the males was the shedding of free sperm into the lumina of seminiferous tubules seen in prepared testis sections. Spermatozoa in fowls require a ripening period of about 24 hours in the excurrent ducts before they are capable of fertilization (Munro, 1938); but in this study, any requirement for sperm to collect or mature in the vasa deferentia or ejaculatory ducts as an essential step in maturation was not considered.

The laying performance of hens held as cage mates of the sacrificed cocks was recorded. This permitted a comparison between the two sexes with respect to the amount of time needed for development of full sexual activity under experimental conditions.

The experiment was begun indoors in January, 1958, with 19 cock and 12 hen Bobwhites 19 weeks old which had been reared on wire and fed a standard poultry growing mash while exposed to nine hours of light per day. One week

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before experimental lighting started, 12 pairs were formed and held one pair to a cage, seven males were caged individually, and all were fed a standard poultry breeding mash. One week later, lighting was conformed with an interrupted dark-period schedule (Kirkpatrick, 1955) in which 10 hours of light were given in two increments, one of nine hours and another of one hour, the latter splitting a 14-hour dark period. Incandescent light intensity at bird level was 30–35 foot-candles and the environmental temperature averaged 60°F., with fluctuations not exceeding about eight degrees. The details of physical arrangements for cages, lighting, and daily management have been described before (Kirkpatrick, 1955).

Samples of lighted cocks were sacrificed at regular intervals. On the beginning day of the experiment, three cocks were sacrificed to establish the weight of unstimulated testes for comparison with testis weights of lighted cocks sacrificed at weekly intervals thereafter.

The number of cocks examined at each interval was chosen to make the best use of the total number available, which was somewhat less than optimum. Previous experience indicated that the longer treatments would result in more unequivocal effects, thus fewer birds were needed for the 5-week sample, since all on that interval were expected to reach full spermatogenesis. Conversely, shorter treatments, up to four weeks at most, were expected to result in unequal development ranging from threshold stimulation of the testis to full spermatogenesis. Consequently, as many birds were examined the first two weeks as during the last three weeks.

The combined weights of testis pairs were determined while fresh on a Roller-Smith torsion balance, and the larger testis of each pair was fixed in an alcohol-formalin-acetic acid mixture. Testis sections were cut and mounted with standard procedures followed by a triple stain. Microscopic inspection of sections provided information on tubule development and spermatogenesis. The average tubule diameter for each group was determined by measuring in each testis the smaller outside diameters of 10 of the most nearly circular seminiferous tubules.

Results and Discussion

A summary of previous experiments is pertinent to the present results which are given in following paragraphs. Kirkpatrick (1955, and unpub. data) found that cock Bobwhites form mature sperm before hens lay eggs, when both receive similar treatment. First eggs from unsacrificed pairs were fertile, indicating transfer of sperm before egg-laying. One pair of Bobwhites produced fertile eggs 14 days after it was placed under incandescent light of 300 foot-candles for 17 hours per 24-hour cycle. Lower intensities (0.1–100 foot-candles) induced fertile eggs on an average of 32 days of lighting in 19 pairs.

In experiments of this nature, egg fertility established the onset of cock potency as occurring roughly no later than ovulation of the particular egg. When the interrupted dark-period method was used, and intensity varied, cocks on one foot-candle had motile sperm after 37 days. Their mates failed to lay during the same period, but hens that were on 10 foot-candles did lay.

The question of how much time is required for cock Bobwhites to produce free sperm under known conditions of artificial lighting is answered by the present results within limits set by the sampling interval. A sampling of cocks at weekly intervals was intended to discover the threshold appearance of free sperm in testis tubules seen in prepared testis sections. The threshold in days for the release of sperm was 7 to 14 days for the most precocious male and 14 to 21 days for the remaining males. The essential information leading to this conclusion is given in the following testis descriptions for the weekly intervals, in Table 1, and in Figs. 1–4.

TABLE 1

TESTIS RESPONSE OF BOBWHITES SUBJECTED TO INTERRUPTED DARK-PERIOD LIGHTING

Treatment, numbers and response	Sacrifice interval (weeks)					
	0	1	2	3	4	5
Total interruptions (hours)	0	7	14	21	28	35
Number in sample	3	4	4	3	3	2
Average testis weight						
Grams	.06	.09	.39	.80	1.30	1.16
Per cent of body weight	.04	.05	.22	.42	.72	.64
Microscopic observations						
Testes with lumina	0	0	4	3	3	2
Testes with free sperm	0	0	1	3	3	2
Ave. tubule diameter (micra)	75	84	158	188	196	194

Testis at 0 Weeks.—After a week of conditioning on nine hours daily of artificial light (at 0 weeks with respect to the stimulating light treatment), the gonads of three cocks were in the typical inactive condition (Fig. 1). Most tubules had two irregular rows of spermatogonia situated near the basement membrane. No lumina were present. Tubules were filled with a matrix in which numerous, scattered large cells with prominent nuclei were in various stages of development or degeneration. The interstitial cells packed within the intertubular spaces had circular nuclei and little cytoplasm. The large intratubular cells appeared similar to those described for passerines (Blanchard, 1941; Wolfson, 1942) and for gulls (Johnston, 1956). In more closely related young pheasants examined in late winter, primary spermatocytes were the most advanced elements, although occasional small lumina were seen (Kirk-

patrick and Andrews, 1944; Hiatt and Fisher, 1947). Since large cells have been observed in inactive testes in several species, and variously referred to as second-order spermatogonia or inactive spermatocytes (Johnston, 1956), I interpret the immature testis of the Bobwhite as conforming to the general picture seen in other birds.

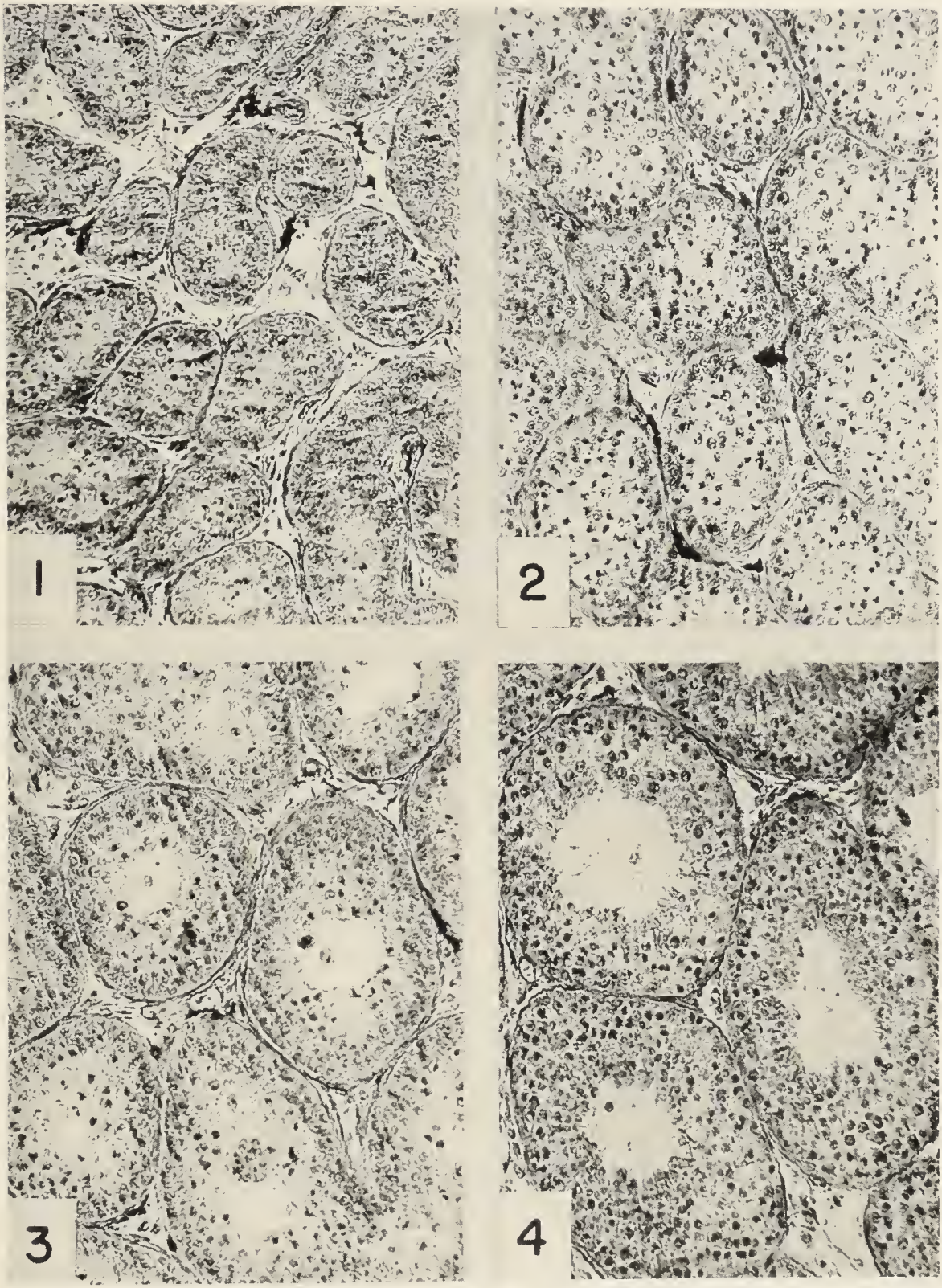
At this stage the average testis weight of 64 mgs. was lowest of the six weekly observations, and corresponded to values of 63 mgs. and 81 mgs. for unstimulated cocks held indoors under "short-day" light (Kirkpatrick, 1955). Average testis weight of unstimulated cocks of comparable age and size held outdoors was 18 mgs. in January, and 34 mgs. in March (Kirkpatrick, unpub. data). The higher values for indoor birds suggest that uniform and higher temperature may cause some increase in testis size.

Testis at 1 Week.—After seven daily 1-hour dark-period interruptions, testis weight and tubule size had increased markedly. No lumina had appeared. Some large cells were still present in the tubule matrix but primary spermatocytes predominated, many in synaptic stages. In some areas the interstitial cells were organized with quantities of cytoplasm not seen the week before (Fig. 2).

Testis at 2 Weeks.—In four individuals, new testis developments ranged from a few lumina and secondary spermatocytes to free sperm in lumina. In the most precocious bird, sperm had collected in the vasa deferentia. The average testis weight for this group exceeded a four-fold increase and average tubule diameter doubled that for the 1-week group. The absolute testis weights ranged 0.26–0.46 grams, with the more advanced spermatogenesis found in the heavier testes. Interstitial tissue was apparently reduced as a whole, but this might have been a mere flattening and redistribution among enlarging tubules as suggested by Rowan (1929) for juncos.

In one bird (Fig. 3), lumina were just opening in some tubules. In another, development had proceeded a bit farther with correspondingly more lumina and a few secondary spermatocytes which were absent in the former. In the third bird, most tubules had sperm bundles attached to the peripheries of wide lumina, but free sperm were absent. The remaining bird had free sperm in most tubules, and sperm had accumulated in the vasa deferentia.

Testis at 3 Weeks.—Testis weights doubled those of the previous sample and tubules were markedly larger. A uniform level of spermatogenic development prevailed throughout the group. All birds had free sperm in some tubules with lumina of most remaining tubules lined with sperm bundles and spermatids (Fig. 4). Some tubules in one testis were clogged with cellular debris. This phenomenon indicated arrested development of single tubules rather than regression of the whole testis, since spermatogenesis was proceeding actively in some tubules and the organ was not of maximum size.



FIGS. 1–4. Cross Sections of Bobwhite Testes, all ×175. FIG. 1. Bird sacrificed at start of experiment after lifetime treatment of nine hours light–15 hours dark. FIG. 2. Bird sacrificed after one week of interrupted dark-period treatment. FIG. 3. Bird sacrificed after two weeks of interrupted dark-period treatment. FIG. 4. Bird sacrificed after three weeks of interrupted dark-period treatment.

Testis at 4 and 5 Weeks.—At the end of four weeks all cocks were sexually functional and maximum testis weights for this experiment were reached. A slight decrease in testis measurements at the final interval is the result of natural variation, as one bird at the 5-week interval, although fully developed, had a lower tissue weight and ratio than any of the 4-week birds. Both groups may be considered as one since all birds were shedding sperm and their testis measurements, uniformly greater than those for the preceding groups, were essentially similar. In terms of function, one precocious male attained full development at two weeks with testis tissue weighing 0.46 grams, and all males were mature in the 3-week group with average testis expansion to 0.8 grams. In previous experiments, I found that Bobwhite testes of 0.3 grams or more usually contain free sperm, and that continued light stimulation caused additional growth to a maximum of 2.1 grams or 1.2 per cent of body weight. The average testis size for 14 cocks after receiving 17 hours daily light (intensities not uniform for all) for 44 days was 1.46 grams (Kirkpatrick, 1955, and unpub. data). When the average testis weight for the 4- and 5-week groups are combined, the resulting value of 1.2 grams shows that testis growth had approached the maximum size recorded for larger samples subjected to more hours of light.

Production of Sperm vs. Eggs.—The laying records of hens kept with the males used in this experiment afforded a comparison with sperm production to determine differential timing of sexual maturity. The comparison is rough because the events compared are not analogous. Free sperm as seen in testis tubules are not analogous to laid eggs, but rather to ovulated ova. Ovulation antedates oviposition by some hours. The time between ovulation and laying, unknown for quail hens, is about 25 hours in the domestic fowl (Warren and Scott, 1935). In this experiment the smallest difference in production thresholds for sperm and eggs was 26 days, more or less. The largest difference was 47 days. Hence, a delay of one or even two days by the quail ovum in the oviduct does not alter the difference significantly.

The first egg was laid 61 days after lighting started. Four hens laid their first eggs on an average of 66 days. Nine hens under observation laid their first eggs in 61 to 109 days (average 80 days). The sperm records made by dissection were in contrast to the egg records. Sperm were found in testes and in vasa deferentia at 2-, 3-, 4-, and 5-week intervals. All males examined after three weeks of lighting had sperm. Therefore, cocks shed sperm in one-half to one-quarter of the time required for hens to lay eggs.

In other experiments differing from the present one with respect to duration, age of birds, and various environmental conditions, first eggs produced were fertile (Kirkpatrick, 1955, and unpub. data). Although the cocks were not examined periodically to establish the earliest presence of sperm, the avail-

able evidence supports the conclusion that, when cock and hen Bobwhites are subjected to similar experimental conditions, the average cock precedes the average hen in sexual maturation.

Summary

When immature Bobwhites were subjected to interrupted dark-period lighting, testis weights and tubule diameters increased, but no lumina had formed after one week of lighting. Testis sections showed that one cock had free sperm in its testes and vasa deferentia after two weeks, and all cocks examined at three, four, and five weeks had responded similarly. The threshold for free sperm production was between 7 and 14 days as contrasted with the first egg at 61 days by a hen on the same treatment. When lighted Bobwhites have produced fertile eggs in much shorter periods, the experiments were not designed for determination of the time differential in sperm and egg production.

Literature Cited

Blanchard, B. D.
1941 The White-crowned Sparrows (*Zonotrichia leucophrys*) of the Pacific seaboard: environment an annual cycle. *Univ. Calif. Publ. Zool.*, 46:1–178.

Hiatt, R. W. and H. I. Fisher
1947 The reproductive cycle of Ring-necked Pheasants in Montana. *Auk*, 64: 528–548.

Johnston, D. W.
1956 The annual reproductive cycle of the California Gull. I. Criteria of age and the testis cycle. *Condor*, 58:134–162.

Kirkpatrick, C. M.
1955 Factors in photoperiodism of Bobwhite Quail. *Physiol. Zool.*, 28:255–264.

Kirkpatrick, C. M. and F. N. Andrews
1944 Development of the testis in the Ring-necked Pheasant. *Anat. Rec.*, 89: 317–323.

Kirkpatrick, C. M. and A. C. Leopold
1952 The role of darkness in sexual activity of the quail. *Science*, 116:280–281.

Munro, S. S.
1938 Functional changes in fowl sperm during their passage through the excurrent ducts of the male. *J. Exp. Zool.*, 79:71–92.

Rowan, W.
1929 Experiments in bird migration. I. Manipulation of the reproductive cycle: Seasonal histological changes in the gonads. *Proc. Boston Soc. Nat. Hist.*, 39:151–208.

Warren, D. C. and H. M. Scott
1935 The time factor in egg production. *Poul. Sci.*, 14:195–207.

Wolfson, A.
1942 Regulation of spring migration in juncos. *Condor*, 44:237–263.

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SUBSPECIES OF THE CANADA GOOSE IN MICHIGAN

BY ARTHUR E. STAEBLER

THE natural occurrence of various subspecies of the Canada Goose (*Branta canadensis*) in Michigan, especially during the breeding season, has been confused during recent decades by strays from domestic flocks and by restocking activities. We can assume, however, that Canada Geese either collected or live-trapped during migration or winter visitant periods are genuine wild birds. This study was made to determine the subspecies of *B. canadensis* which may occur in Michigan during the nonbreeding seasons.

As Delacour (1954:145, 151) has pointed out, our knowledge of Canada Geese is still too scanty to make a satisfactory taxonomic arrangement of the subspecies of this group. There are differences among the various subspecies of *Branta* which are evident only in the living birds. Unfortunately, these differences, such as relative body proportions, voice, actions, and over-all carriage, are generally lost in the study skin. Hanson and Smith (1950:203–204) describe the interesting observations of Indians living in the James Bay region, Ontario, Canada, who recognize four different kinds of Canada Geese on the basis of field characteristics. Mayr (1942:242) points out the role of field characteristics, such as pair formation, family ties, and colonial nesting, in furthering the complex species development in *Branta*.

During a five-year period from 1949 through 1953, I conducted a banding program of Canada Geese at Michigan State University's W. K. Kellogg Bird Sanctuary in Kalamazoo County, Michigan. The Kellogg Sanctuary has been a favorite resting place for fall migrating geese since the early 1930's. The numbers of Canada Geese on the Sanctuary were counted periodically during the fall migration period; the numbers recorded for each year during the course of the study are shown in Fig. 1. There was no way of determining the total numbers of geese that visited the Sanctuary during a given fall. In some years, 1949 in particular, the flocks of geese remained in the area for a prolonged period of time, thus producing a large build-up in numbers as the season progressed. In other years, as in 1950 and 1951, the birds appeared to remain only a day or so in the Sanctuary area before continuing their migration.

A total of 1,115 Canada Geese were examined at the Sanctuary by me during the five-year period; 931 were banded, 60 of these were recaptured in later years, and 64 dead geese were picked up on the Sanctuary grounds for examination. Sex, age, plumage characteristics, weight, and certain morphometrical data (length of wing, tail, culmen) were recorded for each specimen. During the course of the field work certain specimens were saved as study skins, and these were deposited in the collections of the Museum of Zoology, University

of Michigan. Only those subspecies for which there is a specimen collected in Michigan are included in this report, and all specimens referred to here are in the U.M.M.Z.

I am indebted to the late Josselyn Van Tyne, who made the collections and other facilities of the U.M.M.Z. available to me. I also express my gratitude to Jean Delacour for his examination and identification of several specimens, and to Austin Rand for allowing me to examine the specimens of *B. canadensis* in the Chicago Museum of Natural History.

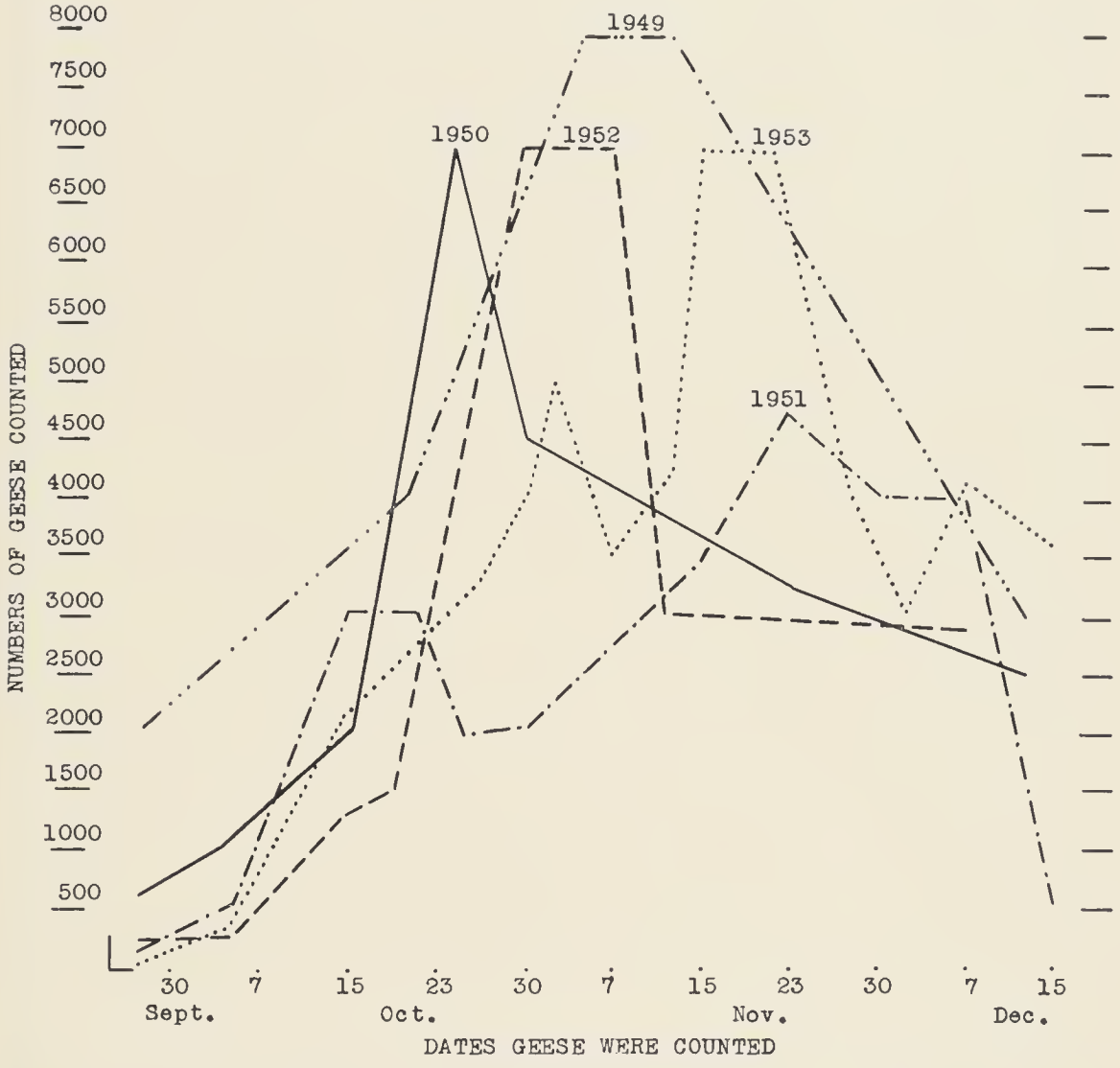

FIG. 1. Numbers of Canada Geese counted on the W. K. Kellogg Bird Sanctuary during the fall migration periods in 1949–1953.

SUBSPECIES ACCOUNTS

Branta canadensis interior.—Four specimens, two identified by Delacour, collected between late October and early December in Kalamazoo County are referable to this form, as are two other specimens taken in early April in Van Buren County. Other specimens of *interior* taken in Michigan include one each from Washtenaw (April), Ingham (November), and Sanilac (December) counties and one from the St. Clair River area (May).

B. c. interior is believed to be the most abundant Canada Goose in Michigan, both as a migrant and as a winter visitant. With the exceptions mentioned beyond, all of the birds handled at the Sanctuary are believed to have been of this race.

Branta canadensis moffitti.—Four specimens of *moffitti*, two of them identified by Delacour, are in the U.M.M.Z. All are from the Kellogg Sanctuary area; three were taken in December, and one in April. Of interest here is one specimen of this race taken in early November on the Ontario, Canada, shores of Lake St. Clair. Although *interior* appeared to be at least 20 times more abundant in the Sanctuary area than *moffitti*, nevertheless, the latter form is regarded as a regular migrant and winter resident in Michigan.

Branta canadensis parvipes.—Two specimens of *parvipes*, both identified by Delacour, have been taken at the Kellogg Sanctuary (October and November). An examination of my original data of geese examined during banding operations indicates that possibly as many as 20 specimens of *parvipes* were banded and released there during the five-year period. *B. c. parvipes* may be regarded as a rare but regular fall migrant in southwestern Michigan; its status elsewhere in the state is unknown.

Branta canadensis taverneri.—*B. c. taverneri* is not recognized in the latest edition of the A.O.U. Check-list (1957). Delacour (1954:168) describes the relationship between *taverneri* and *minima* during the breeding season as very similar to that which exists between *parvipes* and *hutchinsii*. The two smaller forms, *minima* and *hutchinsii*, nest on the coastal tundra while the somewhat larger ones, *taverneri* and *parvipes*, nest inland.

There is a series of specimens of Canada Geese in the U.M.M.Z., collected inland from Point Barrow, Alaska, during the breeding season (late May and early June). These specimens were formerly part of the Max M. Peet Collection and are the specimens of that collection referred to by Bailey (1948:151-155) as *B. c. leucopareia*. On the basis of Delacour's (1954:167) description, I believe these specimens are good examples of *taverneri*. A small Canada Goose was taken by a hunter at the Swan Creek Refuge, Allegan County, Michigan, on October 22, 1954; the specimen, now in the U.M.M.Z., is an adult male and compares very well with the specimens of *taverneri* on hand.

Branta canadensis hutchinsii.—A single specimen of this small goose was taken in Baraga County, Michigan, on October 22, 1949; it is an immature female. Earlier references to *hutchinsii* in Michigan (Sutton, 1927:559; Wood, 1951:44) are subject to question, because the specimens referred to are no longer available for examination, and they may have been any one of the three smaller races of *B. canadensis* now known to occur in Michigan.

During the last two weeks of October, 1949, three small Canada Geese were observed on several occasions on the Sanctuary. Studied with the aid of a 20× spotting scope, the short, stubby bill which is characteristic of *hutchinsii* was evident, and the birds appeared to be little larger than male Mallards (*Anas platyrhynchos*). These small geese were probably *hutchinsii*, but because critical examination in the hand could not be made, their identity remains uncertain.

Branta canadensis canadensis.—No specimens of *B. c. canadensis* in the U.M.M.Z. were taken in Michigan. Presumably, this subspecies may occur within the state, for a specimen of *B. c. canadensis* was taken in November on the Canadian side of Lake St. Clair. None of the specimens handled during the banding operations at the Sanctuary appeared to me to be an example of this race.

Literature Cited

A.O.U. Check-list Committee
1957 Check-list of North American birds (5th ed.). American Ornithologists' Union, Baltimore. xiii + 691 pp.

Bailey, A. M.
1948 Birds of arctic Alaska. Popular Series No. 8, Colorado Museum of Natural History. 317 pp.
Delacour, J.
1954 The waterfowl of the world. Vol. 1. Country Life Limited, London. 284 pp.
Hanson, H. C., and R. H. Smith
1950 Canada Geese of the Mississippi Flyway. *Ill. Nat. Hist. Surv.*, vol. 25, art. 3, 67–210.
Mayr, E.
1942 Systematics and the origin of species. Number XIII, Columbia Biological Series, Columbia Univ. Press, New York. xiv + 334 pp.
Sutton, G. M.
1927 Cackling Goose (*Branta canadensis minima*) in southwestern Michigan. *Auk*, 44:559.
Wood, N. A.
1951 The birds of Michigan. *Misc. Publ. Mus. Zool. Univ. Mich.* No. 75, 559 pp.

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THE 1956–1957 INVASION OF THREE-TOED WOODPECKERS

BY J. DAVID WEST AND J. MURRAY SPEIRS

The fall–winter period of 1956–1957 was highlighted by a major flight of Black-backed Three-toed Woodpeckers (*Picoides arcticus*) and Northern Three-toed Woodpeckers (*Picoides tridactylus*) into southeastern Canada and northeastern United States. Southern Ontario and New England were the principal regions involved, although reports were received from an area extending from Minnesota to the Maritime provinces. The flight was undoubtedly the heaviest on record, at least for southern Ontario, where many observers saw one or both of these usually rare birds for the first time.

Prior to 1956, in southern Ontario, individual Black-backed Three-toed Woodpeckers had been noted in the Toronto region nearly every winter. Minor flights, involving perhaps half a dozen birds, had occurred during a few winters. The Northern Three-toed Woodpecker had been reported from the Toronto region only twice prior to the winter of 1956–57. A bird collected in November, 1901, at Well's Hill is in the Royal Ontario Museum; and a second was seen by R. H. Ivor at Erindale on November 17, 1942.

Acknowledgment

We thank all who assisted with records and other information for this paper, and particularly Mrs. Ruth P. Emery, of Boston, Massachusetts, and Mr. James L. Baillie, of Toronto, Ontario, for New England records and for Toronto and Ontario records, respectively. Others who assisted materially were Dr. W. Earl Godfrey, of Ottawa, Ontario; Dr. W. W. H. Gunn, of Toronto, Ontario; Mr. Fred T. Hall, of Buffalo, New York; Mr. Peter J. Hamel, of Hamilton, Ontario; Mr. Christopher M. Packard, of Brunswick, Maine; Mr. Frank R. Pammett, of Peterborough, Ontario; Mr. Chandler S. Robbins, of the U.S. Fish and Wildlife Service, Laurel, Maryland; and Abbé René Tanguay, of St. Anne de la Pocatière, Quebec.

Flight of Northern Three-toed Woodpeckers

No fewer than eight of these rare woodpeckers were reported from the Toronto region during the winter of 1956–57. The first was found on November 11 at West Hill, scaling the outer bark from the upper branches of a huge elm tree by the side of Highland Creek. A Black-backed Three-toed Woodpecker was working over the same tree, and several observers had the good fortune of seeing both at work side by side. Another which attracted much attention turned up at Glendon Hall, an estate willed to the University of Toronto and within 15-minutes driving time of the main campus. A fine male, discovered at Agincourt on December 30, remained for several weeks, was seen by many observers, and was much photographed. It was subsequently caught by R. R. Taylor, banded, and released.

Most of the reports of the Northern Three-toed Woodpecker in New England were from within its regular range in Maine. However, three were seen in Massachusetts: a pair at Rowley between January 28 and March 31; and a single bird at Milton, in the Boston area, on May 7, one of the late records of this species.

A female Northern Three-toed Woodpecker was seen on December 27, at Genessee Valley Park in New York State. The same bird, possibly, was seen again at Winslow Road, two miles away, on May 11, 1957. This species is decidedly rare in New York State. At Ithaca, it has been observed only once or twice in the past 50 years. A pair was recorded at Raquette, in northern New York, excavating in a spruce on June 10, 1957.

The only report from Michigan was of a specimen collected in the Upper Peninsula in early February, the first taken in the state in many years.

Eight records of this species were received from Quebec, between November 1 (at St. Foy) and May 20 (at Giffard). Both localities mentioned are in the Quebec City area.

From the whole region considered in this report, a total of 59 records of the Northern Three-toed Woodpecker was received (Table 1; Fig. 1). Of these, 28 were from Ontario, only one of which was from within its regular range. There were 16 records from New England, of which four were outside its regular range. The earliest report was on October 28 at Kingston, Ontario, and the latest on June 20 at Pinery Park, Lambton County, in southwestern Ontario.

Seven Northern Three-toed Woodpeckers were reported on the 1956 Christmas counts.

Flight of Black-backed Three-toed Woodpeckers

About five Black-backed Three-toed Woodpeckers were reported for every Northern Three-toed Woodpecker. The total was 293 (compared with 59 Northern), of which 114 were from Ontario and 98 from New England. (See Table 2 and Fig. 2.) There were 32 reports from Quebec, two from New Brunswick, and one from Nova Scotia. New York State had 38 reports, and single birds were reported from New Jersey, Pennsylvania, and Minnesota. Illinois and Wisconsin each reported two, and three reports came from Michigan.

The most southerly records are from Culver's Gap, New Jersey, where one was reported on October 22; Point Pelee, Ontario, October 27; Rockford, Illinois, December 9; Pymatuning Reservoir, March 23 (the first record for western Pennsylvania), and Mill Neck, Long Island, in mid-February. The two seen in Wisconsin, one on October 28 and the other on November 25, were the first reported to the Wisconsin Society for Ornithology since 1951.

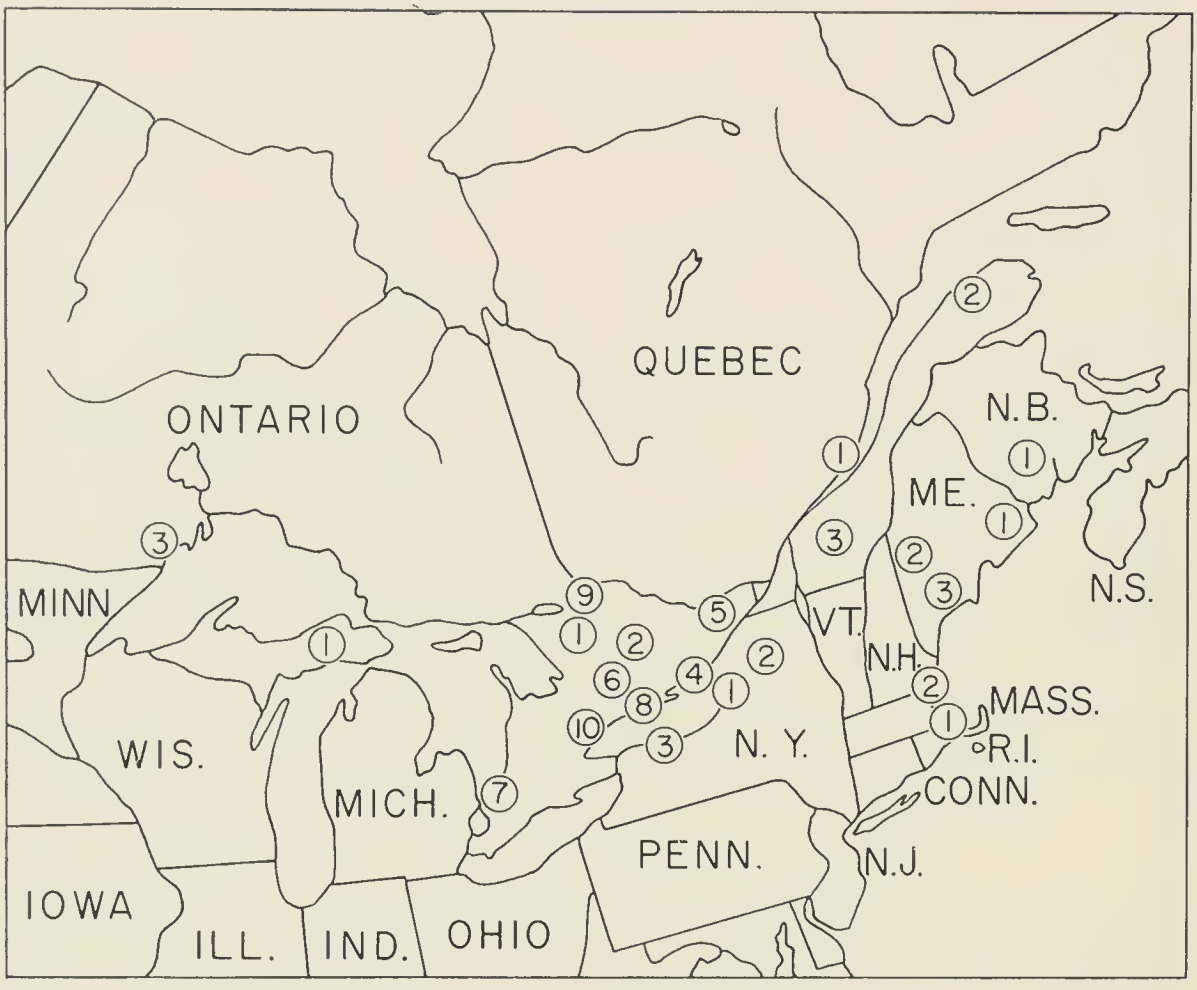

FIG. 1. Records of the Northern Three-toed Woodpecker. Places or areas in each state or province from which records were received are numbered and are listed chronologically in Table 1.

The earliest report received was from Ste. Felicité, Quebec, where a family group of five was seen on August 8, 1956. This, however, was prior to the flight proper, which was first noted (also in Quebec) at Quebec City, where one was seen on September 8 and two on September 22. Another early September report was from Brier Island, Nova Scotia, where a female was banded by Harrison F. Lewis.

The first Ontario report, on September 25 at Barrie, was followed by reports from Commanda, Toronto, and Kingston, in early October. Numerous observations followed, up to early December; they then tapered off sharply, but birds were reported every month up to June 2, at Pickering, in the Toronto area.

The first New England record was at Monhegan Island, Maine, on September 26. On September 29, a specimen was found dead at Haverhill, the first record of this flight for Massachusetts. Of a total of 56 records received from this state, most were in the eastern section. One of the Massachusetts birds

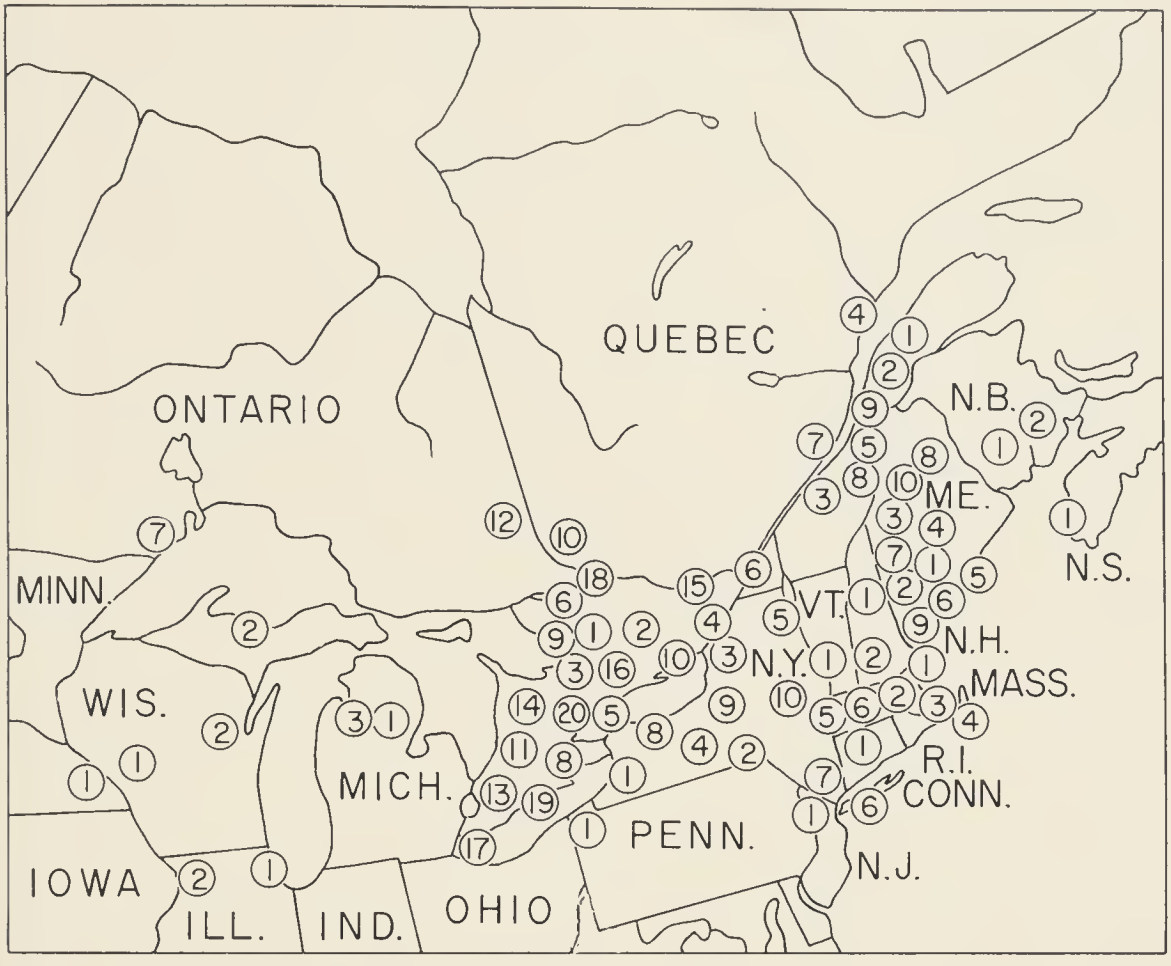

FIG. 2. Records of the Black-backed Three-toed Woodpecker. Places or areas in each state or province from which records were received are numbered and are listed chronologically in Table 2.

was reported from Nantucket, 30 miles off the southeast coast. A bird at Hyde Park, south of Boston, on August 10, 1957, apparently was a left-over from the flight. This was the latest report received from any locality in the flight area. Previously, a major New England flight occurred in the years 1923–1926. Only five records of the species were obtained in the intervening years by the Massachusetts Audubon Society.

The first New York State report was on October 11 at Chenango Valley State Park, and the first for western New York, at Wilson on October 20. Thirty-eight reports were obtained from New York, the Genessee Valley region being the most productive. The normal occurrence of this species at Rochester is one bird every five to ten years.

Thirty-one Black-backed Three-toed Woodpeckers were reported on Christmas counts, including eight at Toronto and five at Rochester.

A great many of the reports stated that individuals of both species were seen on elm trees. In the Toronto region they worked over the elms as high

up as scaly bark was available. This they chipped off, revealing the fawn-colored inner bark. The report from Buffalo, New York, suggested that the attraction may have been the *Scolytus* beetle, a vector of Dutch elm disease.

The heavy flight of Black-backed Three-toed Woodpeckers of 1923–24 in New England was fully reported by Josselyn Van Tyne (1926. *Auk*. 43:469–474). He attributed it to a big population built up in eastern Canada and Maine, resulting in part at least from the activities of the spruce budworm, which had devastated large areas in those regions between the years 1909–1914. Subsequent tree mortality was heavy and was apparent as late as 1924. The dead trees provided ideal conditions for bark beetles and borers, upon a diet of which the three-toed woodpeckers flourished and increased.

The disastrous forest fires of 1955 may have been a contributing factor in bringing about the 1956–1957 flight.

Table 1

Northern Three-toed Woodpecker Records

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
	Maine			
1	Charlotte	March 1	A. E. Davis	1
2	Franklin County			
	Langton Township	Nov. 11	Emery	2
		Nov. 12	Emery	8
	Eustis	Feb. 26	Townsend	1
3	Sidney	Nov. 10	Emery	1
	Massachusetts			
1	Milton	May 7	Charles Ewing	1
2	Rowley	Jan. 28–30	Mrs. C. de Windt, *et al.*	1 ♀
		Feb. 2–March 31	*fide* Ruth P. Emery	1 ♂
	Michigan			
1	Luce County			
	McMillan Township	Feb. 3	Robert S. Butsch	1 ♂ (specimen)
	New Brunswick			
1	Fredericton	Nov. 2	W. A. Squires	1
	New York			
1	Fisher's Landing	March 10	Allen	1
2	Raquette	June 10	Roberta Seamen, *et al.* (*Audubon Field Notes*, Aug., 1957)	2
3	Rochester area			
	Genessee Valley Park	Dec. 27–March	Muchmore, *et al.*	1 ♀
	Winslow Road	May 11	Starling, Bruner	1 ♀
	Ontario			
1	Algonquin Park area			
	Lake Sasajewan	Nov. 3	G. Gibson	1
	Huntsville	Dec. 23	R. J. Rutter	2
	Bella Lake	Jan. 3	C. N. Ireson	1 ♂
2	Bancroft area			
	McGarry's Creek	Jan. 13	D. E. Scovell	1 ♂
	Bancroft	Feb. 9	D. E. Scovell	1 ♀

TABLE 1 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
3	Fort William	Dec. 30	Keith Denis	1
4	Kingston area			
	Kingston	Oct. 28	Arthur Bell	1 ♀
	Bedford Mills	Nov. 10	Alden Strong	1 ♀
5	Ottawa area			
	Ottawa	Late Nov.	acc. to W. Earl Godfrey	1
	Almonte	Dec. 2	W. Earl Godfrey	1
6	Peterborough area	Nov. 3	R. K. Baker. F. R. Pammett	1 ♀
		Nov. 18	R. K. Baker	1 ♂
		Dec. 26	R. K. Baker, F. R. Pammett, D. Sadler	1 ♂
		Feb. 17	R. K. Baker, F. R. Pammett	1 ♂
		April 21	R. K. Baker	1 ♂
7	Pinery Park, Lambton County	June 20	Dr. Keith Reynolds, *et al.*	1 ♂
8	Port Hope area			
	Port Hope	Early Dec.	R. Burness	1
	Canton	ca. Dec. 25	*fide* P. Landry	1
9	Rutherglen	May 16–June 10	Louise de Kiriline Lawrence	1 ♂
10	Toronto area			
	Highland Creek	Nov. 11	G. Fairfield	1 ♀
	Ajax	Nov. 11	W. Campbell	1 ♂
	Glendon Hall	Nov. 17	D. Bryant, E. Waltho, L. Hughes	1 ♀
	Agincourt	Dec. 20	G. Page, R. Wilson	1 ♀
	Port Credit	Dec. 21	Mrs. L. McDougall	1
	Scarboro	Dec. 23	W. Martin	1
	Donalda	Dec. 25	W. Hough	1 ♂
	Agincourt	Dec. 30	J. L. Baillie, *et al.*	1 ♂
	QUEBEC			
1	Quebec City area			
	Ste. Foy	Nov. 1–4	Gaston LePage	1
	Cape Tourmente	Nov. 13	acc. to René Tanguay	3
	Valcartier	Dec. 11	acc. to René Tanguay	1
	Giffard	May 20	Benoit Asselin	1
2	Ste. Anne des Monts	April 6	Frère Charles-Aimé	1
3	Ulverton	March 22	L. M. Terrill	1

Table 2

Black-backed Three-toed Woodpecker Records

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
	Connecticut			
1	New Canaan	Aug.–Oct. 1956	C. Bartow (*Audubon Field Notes*, Feb., 1957)	1
	New Britain	Oct. 9–28	Edwin Austin	2
	Glastonbury	Nov. 18	Dr. Whittles	1
		Nov. 21	Dr. Whittles	1
	West Hartford	Jan. 11	*fide* Mrs. Mary French, *et al.*	1
	New Britain	Feb. 7–April 6	Edwin Austin	1
	Illinois			
1	Chicago	April 28–May 19	Allen C. Montague, (*Audubon Field Notes*, Aug., 1957)	1 ♀
2	Rockford	Dec. 9	R. Earl Olson	1 ♂
	Maine			
1	Androscoggin County			
	Webster	Feb. 24	D. H. Morse	1 ♀
		March 30	D. H. Morse	1 ♂
2	Cumberland County			
	Bridgton	Nov. 22	Edgerton	1
	Gorham	Jan. 17	Poole	1
3	Franklin County			
	Coburn Gore	Feb. 22	De Garmo	1 ♀
	Eustis	April 20	Therrien	1
	Wilton	April 24	Fernald	1 ♂
4	Kennebec County			
	Augusta	Nov. 4	Southard	1
	Farmingdale	Dec. 28	Emery	1
5	Knox County			
	Monhegan Island	Sept. 26	Lawrence	1
	St. George	Oct. 6–12	Hanneman	2 ♂
6	Lincoln County			
	Pemaquid Point	Oct. 12	Mrs. Phillip L. Holden	2
7	Oxford County			
	Baldpate Mountain	Sept. 29	Miss S. Wollaston	1 ♀
8	Piscataquis County			
	Mount Katahdin	Oct. 12	Tabers	2

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
9	Sagadahoc County			
	Bath	April 22	Emery	1
10	Somerset County			
	Brighton	Nov. 14	Gamage	1
	Pleasant Ridge Plt.	Nov. 23	Gamage	1
	Rockwood	March 1	Foss	1 ♀
	The Forks	April 28	N. L. Davis	2
	Moose River	April 28	N. L. Davis	1 ♀
11	Washington County			
	South Addison	Oct. 19	Ewers	1 ♂
	MASSACHUSETTS			
1	Essex County			
	Haverhill	Sept. 29	Mrs. H. Cole	1 (specimen)
	Manchester	Oct. 13	Mr. and Mrs. John Day	2
	Andover	Oct. 25	Craig Roberts, W. Byers	1 ♂
	North Andover	Oct. 31	Brian Harrington	1 ♀
	Magnolia	Nov. 19	Mrs. Edwin S. Rand	1
	North Andover	Dec. 7	Craig Roberts	1 ♀
	Hamilton	Jan.	R. Ames, *et al.*	1
	Rowley	Jan. 27	Ruth P. Emery	1 ♂
	Newburyport	Feb. 2–Feb.28	C. DeWindt, E. Barry	2
	Annisquam	Feb. 27	Mr. and Mrs. R. L. Gaffney	1
	Newburyport	March	*fide* Ruth P. Emery	1 ♀
	North Andover	March 2	Torrey Jackson, John B. Holt, Jr.	1 ♂
	Newbury	April 12	C. DeWindt	1
	North Andover	May 5	Oscar M. Root	1 ♂
2	Middlesex County			
	Lexington	Oct. 6	Mr. and Mrs. F. Cutler	1 ♀
	Hudson	Oct. 22	Mrs. Parker	1
	Winchester	Oct. 27	Mrs. D. W. Kitchin	1
	Hopkinton	Oct. 23	Adelbert Temple	1 ♀
	Weston	Nov. 15	R. Campbell	1
	Concord	Mid-Dec.–Jan. 27	Mrs. Standish Bourne	2
		Feb. 16	T. R. Morse	1 ♀

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
	Framingham	Feb. 23	F. Gleason	1
	Weston	March	Jean Wittenberger	1 ♀
		March 24	Stephen Cribben	1
	Sherborn	April 6	Mr. and Mrs. H. M. Channing	1 ♀
	Lexington	April 23	Mrs. A. H. Meyer	1 ♀
	Concord	May 7	Mary McClintock	1
3	Norfolk County			
	Wellesley Hills	Oct. 14–Nov.25	Wayne Peterson, Mrs. P. L. Holden, K. Elkins	3
	Needham	Dec.	John Willison	1
	Dover	Dec. 16–18	Chas. C. Cabot, *et al.*	3
	Wollaston	Feb. 11	Robert Fox	1 ♀
	Wellesley	March 13–20	Mrs. A. Edmands	2 ♀
	Milton	April 13	Sarah H. Wollaston	1 ♀
	Hyde Park	Aug. 10, 1957	Leon Berig	1 ♂
4	Southeast Massachusetts			
	Nantucket	Oct. 21	John V. Dennis	1 ♂
	Cataumet	Oct. 27	E. C. Johnson	1
	Westport	Dec. 1	Norman Hill	1 ♂
	Berkley	April 18	Mrs. Athearn, *et al.*	2
5	Western Massachusetts			
	Holyoke	Dec. 30	Rudolph Stone	1
	Northfield	Feb. 2	Mr. and Mrs. David A. Pepperell	1 ♀
	Mt. Tom	March 15 and 16	S. A. Eliot, *et al.* (*Audubon Field Notes*, Aug., 1957)	1
6	Worcester County			
	Worcester	Oct. 31	Mrs. Phillip B. Haywood	1 ♀
	Rutland	Dec. 1	Mr. and Mrs. Davis H. Crompton	1 ♂
	Barre	Dec. 7	Davis H. Crompton, David Miner	1 ♂
	Paxton	Dec. 9	Lloyd Jenkins, *et al.*	1 ♀
	Barre	Dec. 16	Davis H. Crompton, David Miner	1 ♀
		May 8	Campbell	1 ♀
	MICHIGAN			
1	Luzern	Nov. 19	L. M. Zimmerman	1
2	Marquette	Feb. 13	Ed Wieland	1

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
3	Kirtland's Warbler Country (First nesting record for the lower peninsula of Michigan)	May 31	Harold Mayfield	Nest with young
	MINNESOTA			
1	Winona	May 4	John Futcher	1
	NEW BRUNSWICK			
1	Fredericton	Early Nov.	*fide* W. A. Squires	1
2	King's County	June 19	(*Nature News* [N. B. Museum], 8[4]:2, July–Aug., 1957)	nest
	NEW HAMPSHIRE			
1	Northern New Hampshire			
	Monroe	Oct. 25–26	Ruby B. Emery, Priscilla Powers	1 ♀
	Littleton	Dec. 2	Ruby B. Emery	1 ♀
	Lancaster	Jan. 27	Mr. and Mrs. Wm. F. Nickerson	1
	Pinkham Notch	Feb.	Miss F. Lawson	1
2	Southern New Hampshire			
	Nottingham	Oct. 20	Mr. and Mrs. N. L. Hatch	1
	Hollis	Oct. 21	W. H. Stimson	1 ♀
	Peterboro	Nov. 8–Dec. 20	W. Patten Hill	2
	New Hampton	March 1	R. Hebert	1
	NEW JERSEY			
1	Culver's Gap	Oct. 22	F. W., *et al.*, (*Audubon Field Notes*, Feb., 1957)	1
	NEW YORK STATE			
1	Buffalo Region			
	Wilson	Oct. 20	Dr. and Mrs. H. Axtell	2
	Letchworth Park	Oct. 28	Clayton Knox	1 ♀
		Nov. 4	Mr. and Mrs. E. Ulrich, *et al.*	1 ♂
	Olean	Nov. 24	Charles Summers	1
	Buffalo	Dec. 9	T. Ucci, Gertrude Webster	1
		Dec. 16	Walker, Gertrude Webster	1
	Armor	April 10	Mrs. Milligan, Mrs. J. Bacon	1
2	Chenango Valley State Park	Oct. 11	Robt. Saunders, *et al.*	2 ♂
3	Clayton area	Dec.–March 10	Belknap, A. W. Allen	2

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
4	Finger Lakes area			
	Sapsucker Woods Pond	Mid-Jan.	David Allen	1
	Ithaca	Feb. 2	per Cornell Ornithology Laboratory	1
5	Keesville	Dec. 8	T. A. Lesperance	1 (specimen)
6	Mill Neck	Mid-Feb.	John Elliott	1♂
7	New York City area			
	Bedford	Oct. 20	Douglas Orbison, *et al.*	1
	New Rochelle	April 28	George Gorman	1 ♂
8	Rochester area			
	1105 Monroe Ave.	Nov. 18–April	Stutz, Klonick, *et al.*	4♀, 3♂
	Scottsville	Nov. 23	O'Hara, Miller	1♀
	Summerville Drive	Dec. 30	Whites	1♀
	Morville Drive	Jan. 2–10	Leo Tanghe	1♀, 1♂
	Long Pond Woods	April 27	O'Hara, Miller	1♀
9	Syracuse area			
	Ava	Dec. 1	A. Jones	1♂
	Fayetteville	Dec. 30	Walter Spoffard	1
	Manlius	Mid-Jan.	*fide* Mrs. R. Gould	1♀
	Baldwinsville	Feb. 17–March 10	F. Scheider, Evans	1♀
		Feb. 24	Mr. and Mrs. J. Smith, *et al.*	1♂, 2♀
10	Watervliet	Dec. 22–Jan. 20	James Merritt	1♀
	NOVA SCOTIA			
1	Brier Island	Early Sept.	Harrison F. Lewis	1♀ (banded)
	ONTARIO			
1	Algonquin Park	Oct. 27	J. L. Baillie, E. V. Stark, *et al.*	1
2	Bancroft area			
	Paudash Lake	Jan. 5	D. E. Scovell	1♀
	McGarry's Creek	Jan. 13	D. E. Scovell	1
3	Barrie area	Sept. 25	Mrs. J. MacLean	1
		Nov. 9	Mrs. J. L. Westman	1
		May 13	L. Whiting	1
		May 18	Mrs. E. S. Lewis, *et al.*	1♂, 1♀

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
4	Brockville area	Nov. 4	D. S. Hurrie	1 ♀
		Dec. 29	J. Cartwright, S. Wilsie	1
		Jan. 1	D. S. Hurrie	1 ♂
		Jan. 12	D. S. Hurrie	1 ♂
5	Cobourg area			
	Brighton	Oct. 19	A. A. Outram	1
	Port Britain	Oct. 26	H. Reeve, L. Steele	1
	Port Hope	Oct. 27	R. Burness	1
	Rice Lake	Early Nov.	Eleanor Ralls	1
	Presqu'ile Point	Nov. 11	Miss A. M. Hughes, *et al.*	1 ♂
		Dec. 16	G. Bennett	1
	Cobourg	Dec. 23	Willow Beach Field Nat. Club	1
	Port Hope	Dec. 23	Willow Beach Field Nat. Club	2
	Grafton	Jan. 6	Miss A. Wilson	1
	Cobourg	Feb. 10	G. Bennett	1 ♂
6	Commanda	Oct. 6–13	Paul Harrington	Flight of 4–5 daily
7	Fort William–Port Arthur	Dec. 26	Keith Denis	1
8	Hamilton area			
	Paradise Rd.–Hwy. #53	Oct. 21–Dec. 1	R. Roy, G. W. North	1
	Strathearne Sewer	Oct. 21–27	H. McPherson	1
	Dundas Marsh	Nov. 17	H. Williams, J. Cummings	1
	Spencer's Creek	Nov. 25	G. W. North, J. Miles	1
	Dundas Marsh	Dec. 1	W. A. T. Gilmore	2
	Westdale	Dec. 9	R. Henry	1
	Mount Albion	Dec. 16	R. Seargent	1
	Sherman St.	Dec. 30	J. Miles	1
	Clappison's Corners	Dec. 30	H. Williams	2
	York Road	Jan. 12	J. Miles	1
	Campbellville	Feb. 2	*fide* P. Hamel	1
	McKittrick's Bridge	Feb. 10	Hamilton Junior Nature Club	1
	Freeman & Westdale	March 1	S. McBride, H. McPherson	2
9	Huntsville	Dec. 23	R. J. Rutter	1

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
10	Kingston area			
	Kingston	Oct. 9	Helen Quilliam	1 ♂
	Westport	Late Oct.	A. Strong	1 ♀
	Bedford Mills	Nov. 10	A. Strong	1 ♂
	Kingston	Dec. 16	A. E. Garwood, W. Lamb	1 ♀
11	Kitchener	Nov. 17	Margaret Lemon	1 ♀
12	Kirkland Lake	Christmas census	J. G. Stephenson	1
13	London	Dec. 2	James Leach, *et al.*	1
14	Orangeville area	Oct. 15	Isobel Miller	2
15	Ottawa area	Fall 1956	*fide* W. Earl Godfrey	Several
		March 1	D. B. O. Saville	1
		April 4	D. B. O. Saville	1
16	Peterborough area	Oct. 28	A. Bunker, F. R. Pammett, J. L. McKeever	1 ♀
		Nov. 4	D. Sadler, F. R. Pammett	1 ♂, 1 ♀
		Nov. 18	R. K. Baker	1 ♂, 2 ♀
		Dec. 26	R. K. Baker, F. R. Pammett, D. Sadler	1 ♂, 2 ♀
		Feb. 9	R. K. Baker	1 ♂
		April 19	F. R. Pammett	1 ♀
		April 21	G. C. Green	1 ♂
17	Point Pelee	Oct. 27	R. E. Mara	1
18	Rutherglen	Fall, 1956	Louise de Kiriline Lawrence	3
19	St. Williams	April 19	Mr. and Mrs. R. Lloyd	1
20	Toronto area			
	Willowdale	Oct. 4	W. Wasserfall	1 ♀ (banded)
		Oct. 11	W. Wasserfall	1 ♂ (banded)
	Colborne Lodge	Oct. 14	W. Higgins	1 ♀
	Glen Major	Oct. 14	Mrs. O. S. Mitchell	1
	Woodbridge	Oct. 14	W. Williams	2
	Pottageville	Oct. 21	L. L. Snyder	1
	Richmond Hill	Oct. 23	Mrs. Curry	1
	Finch Ave., North York	Oct. 24	W. Williams	1 ♂
	Pickering	Oct. 27	R. M. Saunders	1
	Applewood Acres	Oct. 28	J. Dales	1
	Lawrence Ave. E	Oct. 28	Miss McGregor	1

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
	Purpleville	Oct. 28	Mrs. A. J. Ballinger	1 ♀
	Sunnybrook Hospital	Oct. 30	L. Hughes	1
	Willowdale	Early Nov.	W. Wasserfall	1 ♀ (banded)
	Glendon Hall	Early Nov.	E. Waltho	1
	Port Credit	Nov. 1	Mrs. D. R. Gunn	1
	Green River	Early Nov.	Mrs. P. Applegath	1
	Highland Creek	Nov. 4	J. Smith	1 ♀
	Royal Ontario Museum Grounds	Nov. 7	Sylvia Hahn	1
	College Street	Nov. 7	F. Darroch	1
	Bayview Ave.	Nov. 8	C. Atwood	1
	Richmond Hill	Nov. 11	*fide* L. L. Snyder	1
	Lorne Park	Nov. 11	D. R. Gunn, D. Perks	1
	Cherrywood	Nov. 12	M. Armstrong	1
	Port Credit	Nov. 13	D. R. Gunn	1 ♀
	Purpleville	Nov. 17	Mrs. D. Lewis	1 ♂
	Glendon Hall	Nov. 22	J. R. Mackintosh	2 ♂
	Bloor St. W.	Nov. 22	R. W. Trowern	1
	Cedarvale	Nov. 24	R. Pannell	1 ♀
	Glendon Hall	Nov. 27	J. Livingston, R. T. Peterson, J. L. Baillie	1 ♀
	Ajax	Dec. 2	W. Campbell	1 (banded)
	Lorne Park	Dec. 23	J. L. Baillie, *et al.*	4
	Smythe Park	Jan. 5	G. Giles	1 ♂
	James Gardens	Jan. 5	G. Giles	1
	Cooksville	March 20	Mrs. Houghton	1
	Thistletown	April 21	David Moore	1 ♀
	Applewood Acres	April 28	J. Dales	1
	Highland Creek	May 4–6	J. Smith	1 ♂
	Willowdale	May 5–11	W. Wasserfall	1
	Pickering	June 2	R. Taylor, D. O'Brien	1
	PENNSYLVANIA			
1	Pymatuning Reservoir	March 23	Hal H. Harrison	1

TABLE 2 (Continued)

Map Reference No.	Locality	Date	Observers	Number (Sex if given)
	QUEBEC			
1	Barriére Caribou	Sept. 27	*fide* Abbé René Tanguay	1
		Oct. 12	*fide* Abbé René Tanguay	1
2	Biencourt	May 16	Henri Ouellet	1
3	Dosquet	March 13	*fide* Abbé René Tanguay	1
4	Ilets Jeremie	Sept. 4–5	Jacques Normandin	2
5	Lac Frontière	Oct. 18	Louis Amédée Lord	2
6	Montreal region			
	Montreal	Oct. 5	Paul Lebouet	1
	Senneville	Nov. 7–April 23	R. S. and P. C. Abbott	1 ♀
	Hudson Heights	Dec. 30	Mrs. G. A. Golden	1
	Rigaud	March 21	Cercle Jeune Naturalistes	1
7	Quebec City region			
	Quebec City	Sept. 8	Ronald LePage	1
		Sept. 22	*fide* Abbé René Tanguay	2
		Oct. 5	*fide* Abbé René Tanguay	1
	Montmorency	Nov. 11	Francois Hamel	1
	Valcartier	Nov. 11–March 20	*fide* Abbé René Tanguay	2
	Quebec City	Nov. 13	*fide* Abbé René Tanguay	1
	St. Foy	Nov. 25	Gaston LePage	1
	Quebec City	Dec. 1	Ronald LePage	1
		Dec. 29	Raymond Cayouette	1
	Valcartier	March 20	*fide* Abbé René Tanguay	1
	Notre Dame des Laurentides	March 20	Abbé Paul Etienne Sirois, Lucien Robitaille	1
8	St. Fabien de Panet	Dec. 28	Raymond McNeil	1 ♂
9	Ste. Felicité	Aug. 8, 1956	Raymond Cayouette, *et al.*	Family group of five
10	Temiscamingue	Feb. 8	*fide* Abbé René Tanguay	1 ♀
	VERMONT			
1	Okemo Mountain	Oct. 21	Elizabeth Ball	1
	WISCONSIN			
1	Jackson County	Nov. 25	Alan J. Rusch	1 ♂
2	Oconto County	Oct. 28	Carl H. Richter	1

BIRDS OBSERVED DURING TWO ATLANTIC CROSSINGS

BY R. HAVEN WILEY, JR.

Even though a number of excellent papers have been written on pelagic birds of the North Atlantic, there is still a definite need for more information on their distribution. I have recently made two Atlantic crossings between the United States and Europe. This paper consists of my observations of oceanic birds on these voyages and should help to fill some of the gaps in our present knowledge of these birds.

The eastbound crossing in 1957, made on H.M.S. *Queen Elizabeth* from New York to Cherbourg, France, took over four and a half days to complete. The ship left New York Harbor at 11:00 a.m. (E.S.T.), July 11, and docked at Cherbourg at 8:00 a.m. (Cherbourg time), July 16. The course the ship followed was roughly east from New York to 34° West longitude, northwest of the Azores, and then a gradual curve northeast into the English Channel to Cherbourg. The weather was mild for most of the trip. July 12 and the morning of July 14 were overcast with occasional rain, and on the 15th there was a light fog most of the day.

The crossing on the way back in 1958 was made on the S.S. *United States* from Southampton, England, via Le Havre, France, to New York. The steaming time from Le Havre to New York was four days and eight hours from 1:30 a.m. (Le Havre time), August 15, to 8:30 a.m. (E.S.T.), August 19. The course of the westbound crossing was considerably north of the eastbound crossing. From Le Havre the ship followed a gradual curve west and south to approximately 48° West longitude and 41° North latitude. From there it sailed directly to New York (the noon positions for both voyages are given in Table 1). The weather on this trip was similar to that of the preceding one. The morning of August 16 and up to 10:00 a.m. on August 17 were the only overcast periods with the exception of a heavy fog on the afternoon of the 17th.

I have found no previous record of observations on oceanic birds from a ship of this size or speed. Mayr (1938:54) states that ". . . it seems impossible to make satisfactory sea-bird observations on steamers which do much more than 20 knots." However, the *United States* and the *Queen Elizabeth* had cruising speeds of approximately 30 and 27 knots, respectively.

On both trips all my time spent observing birds was from the bow of the ship. I have no means of knowing what species, if any, followed in the wake of the ship. This may have affected the numbers I saw of certain oceanic birds (e.g., Wilson's Petrel, Fulmar) which are reported to follow in the wakes of ships. In the bow of the ship I frequently changed from one side to the other. Except in the few areas where birds were abundant and passing in large

TABLE 1

NOON POSITIONS AND THE NUMBER OF BIRDS SEEN PER HOUR

Voyage	Date	Noon Position	Hours of Observation	Total No. Birds Seen
East (1957)	July 11	South of Long Is.	2	6
	July 12	40° 42′N., 60° 02′W.	5	27
	July 13	41°N., 44°W.	3	1
	July 14	44°N., 29°W.	7	147
	July 15	49°N., 15°W.	3	4
West (1958)	Aug. 15	49° 51′N., 08° 29′W.	4	6
	Aug. 16	48° 38′N., 28° 45′W.	7	115
	Aug. 17	44° 06′N., 46° 56′W.	5	84
	Aug. 18	41° 21′N., 63° 35′W.	4	66

numbers on both sides of the ship at once, I saw nearly all the birds that the ship passed while I was on deck. I used 7× binoculars almost exclusively. On one occasion I tried using a 20× telescope; however, this proved to be unsatisfactory from the moving deck of a ship. I found that the binoculars sufficed in nearly all cases.

On the eastbound voyage I averaged four hours per day observing birds, and five hours per day on the westbound voyage. The exact hours for each day are given in Table 1. On the days when birds were numerous I generally spent more time on deck than on the days when they were scarce. This explains the day to day variation shown in the table. I spent a total of forty hours on deck during both voyages. I kept the exact time that each bird was observed in order that its location could be found.

TABLE 2

NUMBERS OF THE MORE COMMON SHEARWATERS AND PETRELS

Species	Eastbound Crossing					Westbound Crossing			
	July					August			
	11	12	13	14	15	15	16	17	18
Puffinus gravis	—	20	—	50	—	—	56	9	—
Puffinus diomedea	1	—	—	72	2	—	14	4	2
(Unidentified shearwaters)	—	5	—	—	1	1	8	16	—
Oceanodroma leucorhoa	—	—	—	15[1]	—	—	—	3	9
(Unidentified petrels)	—	—	1	—	—	—	1	49	52

[1] Possibly **O. castro** (see text).

Acknowledgment

I wish to express my appreciation to Professor V. C. Wynne-Edwards for his criticism of this paper. I am very much indebted to him for his help and encouragement.

Systematic List

The following is a systematic list of the birds I observed out of sight of land on two Atlantic crossings:

Fulmar (*Fulmarus glacialis*).—Two light-phase Fulmars were seen resting on the water in a heavy fog on August 17, 1958, off the southern tip of the Grand Banks at 43°N. 50°W. The two birds were about three and a half nautical miles apart. Wynne-Edwards (1935: Fig. 12) shows the range of *F. glacialis* on the Grand Banks in July to be no farther south than about 47°N. Rankin and Duffey (1948: Fig. 6), however, do include the southern tip of the Banks in the summer distribution of this species. My observations support Rankin and Duffey's distribution of this species on the Banks but not in mid-ocean. These authors show (Fig. 6) *F. glacialis* ranging south of the 50th parallel west from 15°W. from April to September. However, I saw no *F. glacialis* on August 16 when the *United States* was sailing just south of 50°N.

Cory's Shearwater (*Puffinus diomedea*).—On both crossings this species was ordinarily seen only in small numbers. The only occasion on which it was common was the afternoon of July 14 on the eastbound voyage when over 60 shearwaters of this species were seen, including two flocks of over 15 individuals and several smaller groups. *P. gravis* was entirely absent from the area. On the 1957 trip individuals of *P. diomedea* were observed near both the American and European coasts. On July 15 two shearwaters identified as this species were seen at 48°N. 14°W. and 48½°N. 12°W. respectively, and on the 11th an individual was observed south of Massachusetts at 41°N 71°W. This is an early record for this species in the western Atlantic. Wynne-Edwards (1935:267) mentions that *P. diomedea* does not reach American waters until early August. Gordon (1955:141) found them off southern New England no earlier than July 18 in 1953. However, two early sight records of this species for 1957 were published in *Audubon Field Notes*. (1) Baird and Emery (1957:388) reported two Cory's Shearwaters seen by W. Bailey off Monomoy, Massachusetts, on June 29. (2) Nichols (1957:390) reported 170 observed by P. Buckley off Mecox Bay, Long Island, on July 8. In 1957 there appears to have been an early wave of *P. diomedea* to the southern New England and Long Island coasts. On the westbound crossing the easternmost shearwater of this species was seen at 48½°N. 59°W. and the westernmost individual at 41½°N. 59° W. Both of these positions are over 400 nautical miles farther west and east respectively than the extreme observations on the eastbound voyage.

Greater Shearwater (*Puffinus gravis*).—This species of shearwater was seen frequently in mid-ocean on both crossings. My records generally agree with the range of this species given by Wynne-Edwards (1935: Figs. 5 and 6). The shearwaters seen on July 12 and 14 indicate that *P. gravis* occurs as far south as 40°N. in the western Atlantic and 44°N. in mid-ocean at least up to the second week of July. Wynne-Edwards (1935: Fig. 5) shows that this shearwater is already slightly north of these areas by June 25. On the westbound crossing my observations agree even more closely with this author. In his Fig. 6, Wynne-Edwards shows that the southern limit of *P. gravis* on August 10 approximately corresponds with the 50th parallel. On August 16 at 48½°N. over 50 of these shearwaters were seen, while the next day when four degrees farther south only nine were observed. I never

observed any large flocks of this species of shearwater. Actually, they were most often seen singly or in pairs. The exceptions were a group of nine in the afternoon of July 12, six or seven flocks of shearwaters on the morning of July 14, the three largest of which included over ten *P. gravis* each, and eight shearwaters some of which were this species observed in a flock on August 18. The flocks on July 14 and the one on August 16 all included a few *P. diomedea.*

On the westbound crossing a single *P. gravis* flew along with the bow of the liner at some distance off the beam for ten minutes, having no trouble keeping up with the ship which had a cruising speed of 31 knots. For flight it relied entirely upon the 15 mph wind, flapping only twice during the ten minutes. An individual of this species of shearwater flying at a speed of 15 knots kept up with the ship from which Wynne-Edwards made his observations (Wynne-Edwards, 1935:248). This is the only other record of the flight speed of a shearwater in the North Atlantic that I have been able to find.

I had little trouble separating the present species from *P. diomedea.* I found that the dark, sharply contrasting cap was by far the easiest way to identify *P. gravis.* Other field marks that I used included the conspicuous white patch at the base of the tail, the dark bill, the dark abdomen patch (though it was difficult to observe), and the smaller size when the two species were seen together. The light-colored bill of *P. diomedea* was often noticeable on birds in good light.

Manx Shearwater (*Puffinus puffinus*).—On August 15 three of this species were seen. A single bird was observed 75 nautical miles and two others 195 nautical miles west of the Scilly Isles. All three birds flew under the bow permitting close observation. They were all presumably *P. p. puffinus* but were certainly not the subspecies with darker underparts, *P. p. mauretanicus*, which occurs in the English Channel from June to September (see Nicholson, 1952:51).

Audubon's Shearwater (*Puffinus lherminieri*).—On the westbound voyage in 1958 I observed two together and three single shearwaters that were undoubtedly of this species on August 18 at 41°N. 60°–61°W. Their characteristic flight and smaller size distinguished them from *P. puffinus*, which has the same contrasting color pattern. A distinct brownish hue was seen in excellent light at close range on the upperparts of these five shearwaters. This, according to Murphy (1936:682), is one of the characteristics distinguishing the present species from the Little Shearwater (*P. assimilis*), whose upper surface is slate-colored ". . . without a trace of brownish hue in fresh feathers." *P. assimilis* is the only other small North Atlantic shearwater with a similar flight. In 1957 three shearwaters that appeared to be small enough for *P. lherminieri* were seen at 40°N. 56°W. on July 12. Since their flight was not noticed, there is a possibility that they were *P. puffinus.* These three individuals were in the company of nine *P. gravis.* The color of the under tail-coverts was not seen on any of the birds.

The distinctive flight of *P. lherminieri* is the most noticeable characteristic distinguishing it from the larger *Puffinus* shearwaters. The present species during flight alternates short glides with nearly equal periods of rapid flapping, dividing its flight into a regular pattern. I found that the number of wing strokes between glides varied between five and 15, though less than eight flaps was unusual. *P. puffinus* and the other larger shearwaters are more accomplished at gliding and banking, only taking one or two occasional flaps at irregular intervals. Lockley (1947:15) describes the banking flight of *P. puffinus* in relatively calm weather as ". . . careening from side to side, now skimming the water for fifty yards with one wing-tip, then rising to about ten feet above the surface, beating its wings once or twice or thrice to gather a fresh momentum, then skimming the sea for a similar distance with the other wing down." Several authors mention this difference in the

flight of these two groups of shearwaters. Among them are Peterson (1947:246) and Alexander (1955:28).

I have been able to find very few published records of *P. lherminieri* in the North Atlantic. There are only two positive identifications by authors. A single bird was seen on November 22 at approximately 50½°N. 40°W. by R. L. Grayce (1950:34), who includes no details of plumage or behavior other than that it was in the company of hundreds of *Fulmarus glacialis*. The second identification was of several shearwaters of this species seen off South Carolina and Florida in January and February, 1912 and 1913, by J. T. Nichols (1913:506–508). M. S. Gordon (1955:140) identified some small shearwaters that were almost certainly this species off southern New England in 1953. Two shearwaters which could not be distinguished as to whether they were *P. lherminieri* or *P. assimilis* were seen by Rankin and Duffey (1948:10) in mid-ocean, one in August and the other in December. Along the American coast this species occurs occasionally as far north as Massachusetts. Off southern New England Gordon (1955:141) first found *P. lherminieri* on August 6 when a single bird was seen four miles southwest of Martha's Vineyard. By late August they had become the most numerous shearwater between 39½°N. and 40°N., south of Massachusetts. These records along with my own indicate that in August the range of this species extends as far north as 41°N. and as far out as 60°W. from the American coast, and possibly even to 38°W. if Rankin and Duffey's observation is of this species. However, there are not adequate data to make even these assumptions. Many more specimens and reliable sight records are needed to determine the oceanic range of *P. lherminieri*.

Leach's Petrel (*Oceanodroma leucorhoa*).—This species was the most common of all the petrels that could be identified on both crossings (see Table 2). The North Atlantic petrels are confusing and difficult to distinguish. Several authors (Murphy, 1936:735, 1915:171; Wynne-Edwards, 1935:279; Peterson, 1947:9; Hollom, 1953:16) agree that the flight of *Oceanodroma* alone is sufficient to distinguish it from *Oceanites* and *Hydrobates*. Another author (Rankin and Duffey, 1948:8) states that ". . . the forked tail is difficult to see and therefore should not be relied on for identification." I had very little chance to compare the flight of the petrels of these three genera. In addition to this I found on August 18 several petrels that definitely had forked tails characteristic of *Oceanodroma* but were flying much less erratically than most of the birds of this genus that I observed. For these two reasons, I excluded flight as a positive identification factor of the petrels seen on both voyages, and used only the shape of the tail. In Table 2 I included under *O. leucorhoa* all petrels definitely seen to have forked tails, although it is highly probable that the majority of the unidentified individuals seen on the westbound voyage were also of this species.

The petrels seen on July 14 at 44°N. 29°–30°W. on the eastbound trip might well have been Harcourt's Petrels (*O. castro*) rather than *O. leucorhoa*, as these species are indistinguishable in the field. The position of these petrels indicates that they could very well have been *O. castro*. Wynne-Edwards (1935:282) states that *O. leucorhoa* ranges from 300 to 500 miles off shore. Murphy (1936:736) and Rankin and Duffey (1948:8) also noticed that this species rarely ranges father than 500 miles from the American coast, and none observed any in the eastern Atlantic as far north as Ireland. The 15 petrels I observed were exactly in the middle of the ocean, 950 nautical miles from St. John's, Newfoundland, and 910 nautical miles from the nearest point of the European coast, but only slightly over 310 nautical miles from the breeding grounds of *O. castro* in the Azores. In addition, two completely unidentifiable petrels were seen farther than 500 miles from the American continent—one on July 13 at 41°N. 41°W. on the eastbound trip and the other on August

16 at 48½°N. 30° W. on the return crossing. The petrels shown in Table 2, seen on August 17 and 18, were all within 500 miles of land.

Storm Petrel (*Hydrobates pelagicus*).—One of these petrels was identified on August 15 on the westbound crossing approximately 190 nautical miles west of the Scilly Isles. Its flight was fairly straight with fast wing-beats, apparently distinguishable from that of *Oceanodroma*.

Wilson's Petrel (*Oceanites oceanicus*).—The only individual of this species identified on either trip was observed on August 18 at 41°N. 67°W. The characteristic feet that project beyond the end of the tail were seen at close range. It is interesting that I saw only once on both voyages a petrel so common in the North Atlantic. Mayr (1938:57) had a similar experience in 1938.

Gannet (*Morus bassanus*).—Only one bird of this species was observed a great distance from land. This was a juvenile seen about 150 nautical miles south of this species' breeding colonies in southwestern Ireland on July 15, 1957. *M. bassanus* became more common in the English Channel nearer to land.

?Phalarope.—An unidentified bird was seen on July 12 at 40½°N. 60°W., 420 nautical miles from New York. The general color of the upper surface was brown, streaked with a lighter color. The bird did not have a white rump-patch which is characteristic of the petrels. Migration dates do not support the possibility of this bird actually being a phalarope. August 14 is the earliest date given by Urner and Storer (1949:186) for the Northern Phalarope (*Lobipes lobatus*) on the New Jersey coast. Griscom (1939:185) found this species in Massachusetts on July 24, 1938—an early record. The migration of the Red Phalarope (*Phalaropus fulicarius*) is even later than that of *Lobipes*. Griscom (*ibid.*) showed that the main fall flight of *Phalaropus* is most likely far offshore sometime between late September and late October.

Long-tailed Jaeger (*Stercorarius longicaudus*).—Of the 11 jaegers I observed on the westbound voyage I was able to identify three as this species on August 16 at 48°–47°N. 26°–23°W. The first of these, seen flying close to the ship, was missing its projecting tail feathers and was identified by the restriction of white in the primaries to only the outer few feathers, the clear white breast, and the slenderness of the body. The other two jaegers of this species had their tail feathers intact. My observations agree with Wynne-Edwards' (1935:310) report that this species begins autumn migration in the last week of July, reaching a peak in the second half of August. Seven of the jaegers seen on the westbound crossing were too far from the ship to be identified. All of these were seen on August 16, except one that was observed the day after at 43°N. 50° W. The majority of the jaegers were found in the vicinity of Arctic Terns (*Sterna paradisaea*). Twenty-five terns were seen on August 16 when all but one of the jaegers were observed. However, jaegers were not found near all of the terns, and also four jaegers seen in the afternoon were found three to 22 nautical miles from the nearest terns. On the 17th, when only one jaeger was observed, no terns were seen all day.

?Parasitic Jaeger (*Stercorarius ?parasiticus*).—On August 16 at 48°N. 29½°W. a jaeger was observed with extensive white patches in the primaries and a prominent breast band. No projecting tail feathers could be seen to determine whether it was the Pomarine Jaeger (*S. pomarinus*) or *S. parasiticus*. However, considering the migration dates of these two species, the latter seems more probable. Wynne-Edwards (1935:304–305) observed that the migration of *S. parasiticus* begins in the last week of July, although the peak of migration does not come until the first week of September. *S. pomarinus* does not start south from its breeding grounds until the middle of August (Wynne-Edwards, 1935: 300).

Kittiwake (*Rissa tridactyla*).—I identified one adult of this species approximately 32 nautical miles west of the Scilly Isles on August 15, 1958.

Arctic Tern (*Sterna paradisaea*).—Twenty-five terns were seen on the westbound crossing in the middle of the Atlantic from 49°N. 24°W. to 48°N. 30½°W. on August 16. The color of their bills, necessary for their identification, was extremely hard to observe from the ship. The entirely red bills characteristic of *S. paradisaea* were eventually seen on three of the terns at close range. The majority of the terns seen were adults. However, there were a few in juvenile plumage with white foreheads, brown areas in their wings, and large amounts of black on their bills. The flight of these terns was not strong enough to enable them to keep up with the ship. August 16 is well within the migration dates given by Wynne-Edwards (1935:327), who states that autumn migration starts before the end of July, and Rankin and Duffey (1948:26), who, although they observed only two terns in July in mid-ocean, found that "the migratory movements continued in small numbers throughout August across the breadth of the ocean." Mayr (1938:54) observed five *S. paradisaea* in the eastern Atlantic on July 31.

Two unidentified terns were seen south of Long Island on July 11, 1957.

Summary

On two recent Atlantic crossings on passenger liners, 450 individuals of 12 species of birds were observed out of sight of land. *Puffinus gravis* was the most numerous representative of the shearwaters and *Oceanodroma leucorhoa* of the petrels. The oceanic range of *Puffinus lherminieri* extended as far north as 41°N. 60°W. during August, 1958. In 1957, *Puffinus diomedea* was observed off the American coast by July 11. In general, my observations confirm those of previous authors.

Literature Cited

Alexander, W. B.
1955 Birds of the ocean. Putnam, Boston.

Baird, J. and R. Emery
1957 *Audubon Field Notes*, 11:388.

Gordon, M. S.
1955 Summer ecology of oceanic birds off southern New England. *Auk*, 72:138–147.

Grayce, R. L.
1950 Bird transects on the North Atlantic. *Wilson Bull.*, 62:32–35.

Griscom, L.
1939 Migration of the Red Phalarope off Massachusetts. *Auk*, 56:185.

Hollom, P. A. D.
1953 The popular handbook of British birds. H. F. and G. Witherby, London.

Lockley, R. M.
1947 Shearwaters. Devin-Adair, New York.

Mayr, E.
1938 Birds on an Atlantic crossing. *Proc. Linn. Soc. N.Y.*, 49:54–58.

Murphy, R. C.
1915 The Atlantic range of Leach's Petrel (*Oceanodroma leucorhoa* (Vieillot)). *Auk*, 32:170–173.
1936 Oceanic birds of South America. Macmillan Co. and Amer. Mus. Nat. Hist., New York.

Nichols, C. K.
1957 *Audubon Field Notes*, 11:390.
Nichols, J. T.
1913 Notes on offshore birds. *Auk*, 30:505–511.
Nicholson, E. M.
1952 Shearwaters in the English Channel. *Brit. Birds*, 45:41–55.
Peterson, R. T.
1947 A field guide to birds. Houghton Mifflin, Boston.
Rankin, M. N. and E. A. G. Duffey
1948 A study of the bird life of the North Atlantic. *Brit. Birds*, 41:suppl. 1–42.
Urner, C. A. and R. W. Storer
1949 The distribution and abundance of shorebirds on the north and central New Jersey coast, 1928–1938. *Auk*, 66:177–194.
Wynne-Edwards, V. C.
1935 On the habits and distribution of birds on the North Atlantic. *Proc. Boston Nat. Hist. Soc.*, 40:233–346.

210 Pleasantview Avenue, Louisville, Kentucky, July 9, 1959

CHANGES IN THE BREEDING BIRDS OF BIRD HAVEN SANCTUARY OVER A PERIOD OF FORTY-FIVE YEARS

BY PERNA M. STINE

Bird Haven, the Robert Ridgway Memorial Bird Sanctuary and Arboretum, just north of Olney, Richland County, Illinois, had its beginning in October, 1906, only three years after the Federal Government established its first sanctuary. Robert Ridgway, then Curator of Birds at the United States National Museum, bought eight acres of young timber as a country home, a bird sanctuary, and an arboretum.

Interested in birds from his early childhood, Ridgway had begun, at the age of 13, to keep records of the birds of his home, Mt. Carmel, Illinois. In his search for the names of the birds he observed, chance brought him a great teacher, Spencer F. Baird of the Smithsonian Institution, who not only named the bird drawings Ridgway sent him, but gave help in keeping his bird records and in improving his bird pictures. With four years of bird observations completed, Robert Ridgway, through Baird's recommendation, was appointed Zoologist for the survey of the 40th Parallel in the far west. When only a boy of 17, Ridgway left for this outstanding position (April, 1867) with the resolve to return some day to live in southern Illinois.

After 40 years of waiting, Bird Haven with its wooded hills, treeless lowlands, and spring-fed stream was that dream come true. Many scientific articles and books had come from Robert Ridgway's pen in those years, his thirty-first being his observations on the birds of the Lower Wabash Valley (Ridgway, 1874). Since 1894 his work at the Museum had been the writing of "Birds of North and Middle America," a great undertaking, but one which advanced his return to southern Illinois. He could live in the country and continue his writing. With the preparatory planning and research much advanced, the first three volumes published, and the fourth (Ridgway, 1907) in progress, he bought Bird Haven. During three summers Ridgway and his wife lived there, counted the birds as they arrived, and listed the breeding birds and the unusual migrants. In 1908, the Ridgways' country home was increased to 18 acres.

During the summer of 1910 they lived in the big house on the farm adjoining Bird Haven on the north and east. Mr. Ridgway found time to search the farm for breeding birds not found on Bird Haven. The extreme heat of that summer revealed that Bird Haven was not desirable as a summer home. In October, a modern brick house on eight acres of ground was purchased in South Olney. The name, Larchmound, given by the original owner, was retained, and here the Ridgways lived the summers of 1911 and 1912, and began "year round" living in June, 1913 (Ridgway, 1915*a*).

Mr. Ridgway's plans for an endowment for Bird Haven were incomplete at the time of his sudden death on March 25, 1929. Mrs. Frances K. Hutchinson, a woman of means, a friend of conservation and of Mr. Ridgway and his work on Bird Haven, not only increased the endowment beyond Mr. Ridgway's figure but added the farm (about 100 acres) where the Ridgways had lived in 1910. This memorial to Robert Ridgway she deeded to the University of Chicago in 1932 (see Fig. 1).

I began the present study because there were breeding birds at Bird Haven that were new to me: American Woodcock, Bell's Vireo, and Cerulean Warbler. The work was planned by the late W. C. Allee, who stressed the fact that changes in the bird population could be expected due to changes in the vegetation since the publication of Ridgway's list (1914). My first observations were made in 1945 (78 hours), and annual studies were made from 1947 through 1955. For most of this period, I spent an average of 160 hours per year on the study area, but in 1954 daily trips were made during April, May, June, and most of July, for a total of 270 hours. All observations are my own except for that of Traill's Flycatcher, which was seen and heard by Robert Kirby on May 1, 1954. The House Sparrow (*Passer domesticus*) was omitted from the study.

Evidence of nesting was determined by finding an occupied nest, by seeing young being fed, or by finding a singing male throughout the breeding season. Only the Yellow-throated Vireo was listed as a nesting species on the basis of a singing male on the area. The persistent efforts of the Marsh Hawk to drive off intruders from a portion of the farm give it nesting status as far as I was concerned.

The nesting of the Whip-poor-will was in doubt until May 1, 1954, when a group of visitors flushed the adult from a nest. Jerry Chaniot from Decatur was the first to locate the nest with its two eggs. The Whip-poor-will was given regular nesting status because it was heard singing in other years. The Ruby-throated Hummingbird's nest was found when a strong wind dislodged it during August, 1954.

It gives me great pleasure to acknowledge the cooperation and valuable assistance I reeeived from several bird students of the Olney area: Mrs. Chester Scherer, who has bird records for more than 25 years; Mrs. Vera Scherer Shaw; and Mr. and Mrs. W. R. Bridges.

After 47 years, the young trees of the 18 acres, both the native forms and those added by Mr. Ridgway, show some of the grandeur, vine-drapery, and abundant undergrowth of a virgin forest. Trees grow rapidly in southern Illinois, as shown by measurements of several fallen specimens on Bird Haven, just eight years old (Ridgway, 1918:8). A sycamore (*Platanus occidentalis*) had a diameter of 12 inches and a height of more than 40 feet; the elms (*Ulmus americana*) were only slightly smaller than this. The fallen tree is

becoming more common and here and there are "den" trees. The tree growth on the lowlands almost hides the main stream on the 18 acres as well as its many divisions on the farm. The more or less heavily wooded stretches of the farm, except for some planted areas, are the result of Nature being allowed to take over the cultivated fields and pastures of 1910 and later. The wooded stretches on either side of the north part were planted by the University. A shrubby growth covers what appears to be open spaces on the farm.

Breeding Birds 1945–1955

The 18-acre woods, with paths used for 50 years, supported 41 nesting species (Table 1). Only 39 species nested there until 1954, when the Prothonotary Warbler nested in a stump of a river birch (*Betula nigra*) along an overflow of the main stream, and the Yellow-throated Warbler made its home in a tall sycamore. Both species returned to nest the next year.

The farm, reduced to 85 acres in the early part of the study, is unlike the woods in having no paths. Fifty breeding species (Table 1) were found there, with the count in 1945 being the largest, when three of the four new breeding species were present.

The two areas attracted 31 of the same species for nesting. Ten species nested only in the woods, whereas 19 species nested only on the farm. In recent years it has seemed that some species, now confined to the woods, may in time nest on the farm. The Prothonotary and Yellow-throated Warblers, for example, were seen many times along the stream on the farm even through early June, during the last two years of the study.

There were eight breeding birds new to the area since 1910, with only the Starling present each year (1945–1955). This species was first seen in the Olney area by Mr. Ridgway in January, 1928, as reported by Brodkorb (1929).

Comparison of Breeding Birds of 1907–1910 and 1945–1955

The first report (Ridgway, 1914), for the period of 1907–1910, listed 72 breeding birds for the woods and the farm. In 1927 the Song Sparrow became the seventy-third breeding species (Ridgway, 1929*a*:1). In the period of 1945–1955, 52 of the 73 species nested in either the woods or the farm, the distribution being 37 on the 18 acres and 46 on the farm. For the early period, about 73 per cent of the breeding species were recorded for the 18 acres in the four years of observation (1907–1910), while the farm, with one year of observation (1910), had only 25 per cent of the total. It would appear that Ridgway searched the farm in order to find breeding birds not found on the 18 acres, rather than to list all breeding birds. It seems safe to assume that some of the breeding species were common to both areas then, as is true today.

FIG. 1. Aerial photograph of Bird Haven and surroundings made by the U. S. Department of Agriculture, July 24, 1953. North is at the top. Dotted lines show approximate boundary of the sanctuary today. The 18 acres in the south portion show a dense woods with few open spaces. Note the wooded stream leaving the farm on the east.

TABLE 1

BREEDING BIRDS OF BIRD HAVEN SANCTUARY

Species	Status				No. of Years Present
	1907–1910		1945–55		
	Woods	Farm	Woods	Farm	
Green Heron (*Butorides virescens*)	B			B	9
Red-shouldered Hawk (*Buteo lineatus*)	B		B	B	10
Marsh Hawk (*Circus cyaneus*)*				B	1
Sparrow Hawk (*Falco sparverius*)	B			M	1
Bobwhite (*Colinus virginianus*)	B			B	10
Killdeer (*Charadrius vociferus*)		B	Flying over		1
American Woodcock (*Philohela minor*)		B		M	2
Spotted Sandpiper (*Actitis macularia*)		B			
Mourning Dove (*Zenaidura macroura*)	B		B	B	10
Yellow-billed Cuckoo (*Coccyzus americanus*)	B		B	B	10
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	B		M	M	4
Barred Owl (*Strix varia*)	B		B		10
Whip-poor-will (*Caprimulgus vociferus*)	B		B		10
Chimney Swift (*Chaetura pelagica*)*				B	1
Ruby-throated Hummingbird (*Archilochus colubris*)		B	B	B	10
Yellow-shafted Flicker (*Colaptes auratus*)	B		B	B	10
Red-bellied Woodpecker (*Centurus carolinus*)	B		B	B	10
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	B		B	B	6
Hairy Woodpecker (*Dendrocopos villosus*)	B		B	B	10
Downy Woodpecker (*Dendrocopos pubescens*)	B		B	B	10
Eastern Kingbird (*Tyrannus tyrannus*)	B			B	10
Great Crested Flycatcher (*Myiarchus crinitus*)	B		B	B	10
Eastern Phoebe (*Sayornis phoebe*)	B		B		10
Acadian Flycatcher (*Empidonax virescens*)	B		B	B	10
Traill's Flycatcher (*Empidonax traillii*)		B		M	1
Eastern Wood Pewee (*Contopus virens*)	B		B	B	10
Purple Martin (*Progne subis*)*				B	1
Blue Jay (*Cyanocitta cristata*)	B		B	B	10
Common Crow (*Corvus brachyrhynchos*)	B		B	B	10
Carolina Chickadee (*Parus carolinensis*)	B		B	B	10
Tufted Titmouse (*Parus bicolor*)	B		B	B	10
White-breasted Nuthatch (*Sitta carolinensis*)	B		B		10
House Wren (*Troglodytes aedon*)	B		B	B	8
Bewick's Wren (*Thryomanes bewickii*)		B	B	B	5
Carolina Wren (*Thryothorus ludovicianus*)	B		B	B	10
Mockingbird (*Mimus polyglottos*)		B		B	1
Catbird (*Dumetella carolinensis*)	B		B	B	10
Brown Thrasher (*Toxostoma rufum*)	B			B	10
Robin (*Turdus migratorius*)	B		B	B	10
Wood Thrush (*Hylocichla mustelina*)		B	B	B	10

TABLE 1 (Continued)

Species	Status 1907–1910 Woods	1907–1910 Farm	1945–55 Woods	1945–55 Farm	No. of Years Present
Eastern Bluebird (*Sialia sialis*)	B		B	B	10
Blue-gray Gnatcatcher (*Polioptila caerulea*)	B		B	B	10
Cedar Waxwing (*Bombycilla cedrorum*)		B		B	10
Starling (*Sturnus vulgaris*) *			B		10
White-eyed Vireo (*Vireo griseus*)	B			B	3
Bell's Vireo (*Vireo bellii*)		B		B	10
Yellow-throated Vireo (*Vireo flavifrons*)	B		B	B	3
Red-eyed Vireo (*Vireo olivaceus*)	B		B	B	10
Warbling Vireo (*Vireo gilvus*)		B	M	M	2
Black-and-white Warbler (*Mniotilta varia*)		B	M	M	10
Prothonotary Warbler (*Protonotaria citrea*) *			B		2
Yellow Warbler (*Dendroica petechia*)		B		B	1
Cerulean Warbler (*Dendroica cerulea*)		B	M		2
Yellow-throated Warbler (*Dendroica dominica*) *			B		2
Prairie Warbler (*Dendroica discolor*) *				B	1
Ovenbird (*Seiurus aurocapillus*) *			B		2
Louisiana Water Thrush (*Seiurus motacilla*)	B		B		3
Kentucky Warbler (*Oporornis formosus*)	B		B	B	10
Yellowthroat (*Geothlypis trichas*)	B			B	10
Yellow-breasted Chat (*Icteria virens*)	B			B	10
American Redstart (*Setophaga ruticilla*)	B		M	M	10
Eastern Meadowlark (*Sturnella magna*)	B			M	10
Redwinged Blackbird (*Agelaius phoeniceus*)	B			M	2
Orchard Oriole (*Icterus spurius*)	B			B	10
Baltimore Oriole (*Icterus galbula*)	B		M		10
Common Grackle (*Quiscalus quiscula*)		B	M	M	2
Brown-headed Cowbird (*Molothrus ater*)	B		B	B	10
Scarlet Tanager (*Piranga olivacea*)	B		M	M	10
Summer Tanager (*Piranga rubra*)	B		B	B	10
Cardinal (*Richmondena cardinalis*)	B		B	B	10
Blue Grosbeak (*Guiraca caerulea*)	B		M		2
Indigo Bunting (*Passerina cyanea*)	B		B	B	10
Dickcissel (*Spiza americana*)		B	M		1
American Goldfinch (*Spinus tristis*)		B		B	10
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	B			B	10
Grasshopper Sparrow (*Ammodramus savannarum*)		B			
Lark Sparrow (*Chondestes grammacus*)		B			
Bachman's Sparrow (*Aimophila aestivalis*)	B				
Chipping Sparrow (*Spizella passerina*)	B		B		10
Field Sparrow (*Spizella pusilla*)	B			B	10
Song Sparrow (*Melospiza melodia*)	B		M	M	10

Key: Woods—the 18 acres; Farm—land added to Bird Haven in 1929; B—Breeding; M—Migrant; * species added in the 1945–1955 study.

Of the 21 species no longer nesting in either area, 17 were migrants in one or both areas in the 10 years of this study (see Table 1). Three of the remaining four were seen in the Olney area, the Spotted Sandpiper as a migrant, the Grasshopper and Lark Sparrows as breeding birds. Bachman's Sparrow, however, was not seen in any part of Richland County in the whole 10 years. This species seems to have made the most decided change of the 21 species.

There were changes in the breeding birds in both the woods and the farm in the 10 years, most of which were from unknown causes. Only the absence of the Chimney Swift, Purple Martin, and Mockingbird after the first year, seemed to have an explanation. All were associated with the home of the custodian in 1945. After this house burned and the site, some 13 acres, was sold, these species failed to find a new nesting location, even though the martin house was moved to the new home in the woods. The Prairie Warbler, found nesting on the farm in 1945, was seen only once after that (May 2, 1954).

My lack of knowledge of the song of Traill's Flycatcher may account for the limited records for this species. A report of breeding birds on Larchmound (Ridgway, J. E., 1924:38) states that this species nested only one year out of seven. Mr. Ridgway had only one record of the nesting of the Blue Grosbeak.

Changes in Bird Life

Mr. Ridgway wrote (1929*b*:177) to Frank M. Chapman that "As years go by I am more and more impressed by the marked difference in bird life in different years. This is true of both summer and winter residents." Seventy per cent of the breeding species of the 1907–1910 period did not change in the 45 years; the 30 per cent that did change are given attention here.

The 21 species no longer nesting in either the woods or the farm may be separated into two groups: (1) species nesting in the Olney area; and (2) species nesting outside the Olney area. The varying abundance of Group (1) is shown by the listing as common, uncommon, or rare elsewhere in the Olney area.

Common—each in a habitat not well represented on Bird Haven:

Sparrow Hawk	Redwinged Blackbird
Killdeer	Common Grackle
Warbling Vireo	Dickcissel
Eastern Meadowlark	Song Sparrow

Uncommon—known to nest *some* years, the last two species in habitats not found on Bird Haven:

American Woodcock	Grasshopper Sparrow
Baltimore Oriole	Lark Sparrow

Rare—known nesting limited to the dates given:

Cerulean Warbler, 1954, 1955

American Redstart, 1955

There are no recent nesting records for the following species at Bird Haven or the Olney area:

Spotted Sandpiper
Black-billed Cuckoo
Traill's Flycatcher
Black-and-white Warbler
Scarlet Tanager
Blue Grosbeak
Bachman's Sparrow

The present status of eight species that were on the decrease in 1915 (Ridgway, 1915*a*, *b*, *c*) may be summarized as follows:

Yellow Warbler: Absent; one known nesting in 45 years.

Baltimore Oriole: On the decrease until 1950, but some nesting since that time.

White-eyed Vireo: Present in most years but irregular.

Dickcissel: Common, but makes frequent changes in nesting field.

Carolina Wren, Wood Thrush, Warbling Vireo, and Yellow-breasted Chat: Abundant. The first two were reported as common by 1929 (Ridgway, 1929*a*:1).

Summary and Conclusions

This study (1945–1955) of the bird life of the 18 acres of woods and the 85 acres of farm land composing Bird Haven resulted in the recording of 60 species of breeding birds, 41 for the woods and 50 for the farm. Slightly more than half of the 60 species were found in both areas.

The woods had 10 species of breeding birds not found on the farm, whereas the latter, with a greater area and a more varied habitat, had 19 species not found in the woods.

A comparison with the list of the birds found breeding here by Ridgway in the period 1907–1910 showed 52 species still nesting in either the woods or the farm, more than half being found in both regions. Twenty-one species of the earlier report no longer nested in either; 17 of these were recorded as migrants in this study, and 14 were known to nest in the Olney area, many in habitats not well represented in either the woods or the farm. Seven species, or one-third of the 21, for which there were no nesting records for the Olney area in 10 years, were thought to have changed their nesting for unknown causes.

The bird life of the study area changed over the 10-year period in this study, as well as over the relatively long period (40 years) between the two studies. These changes were apparently due to changes in habitats. Some species on

the decrease in 1915 were common to abundant for the whole period of the present study, while others were absent. One, the Baltimore Oriole, on the decrease for more than 50 years, returned to nest in small numbers in the Olney area since 1950, while the Yellow Warbler, scarce in 1915, has not reappeared. Only one (Starling) of the eight new breeding species of this study was present each year.

Literature Cited

Brodkorb, P.
1929 Summer notes from southern Illinois. *Auk*, 46:398.

Ridgway, R.
1874 The lower Wabash Valley, considered in relation to the faunal districts of the eastern region of North America with a synopsis of its avian fauna. *Proc. Boston Soc. Nat. Hist.*, 16:1–31.
1907 Birds of North and Middle America. *U.S. Nat. Museum*, no. 50. Part IV:1–973.
1914 Bird-Life in southern Illinois. I. Bird Haven. *Bird-Lore*, 16:409–420.
1915*a* Bird-Life in southern Illinois. II. Larchmound: A Naturalist's Diary. *Bird-Lore*, 17:1–7.
1915*b* Bird-Life in southern Illinois. III. Larchmound: A Naturalist's Diary. *Bird-Lore*, 17:91–103.
1915*c* Bird-Life in southern Illinois. IV. Changes which have taken place in "Half a Century." *Bird-Lore*, 17:191–198.
1918 The need for forests and game preserves in southern Illinois. *Aud. Bull.* Winter, 1918–19:5–11.
1929*a* Bird Haven—its purpose and present status. *Bird-Lore*, 31:1–6.
1929*b* Letter to Frank M. Chapman. *Bird-Lore*, 31:173–178.

Ridgway, J. E.
1924 Larchmound. Arbor and Bird Day, *Illinois Circular*, no. 183:34–38.

1304 tenth avenue, zephyrhills, florida, march 13, 1959

GENERAL NOTES

Pileated Woodpecker attacks pilot black snake at tree cavity.—Although the Pileated Woodpecker (*Dryocopus pileatus*) and the pilot black snake (*Elaphe obsoleta*) occur together in the woodland habitat of much of the eastern United States, an incident in which this snake climbed a tree to eat nestling Pileated Woodpeckers was considered "remarkable" by Hoyt in her report on the latter species (1957. *Ecology*, 38:246–256). On the occasion mentioned, the observer rescued the young birds and thus lost the chance of witnessing the response of the adult woodpeckers to the predator. Information about such a response is desirable because the woodpecker may encounter this common arboreal, bird-eating snake more frequently than the reported evidence would indicate, and because, in general, very little is known about predation in the ecology of the Pileated Woodpecker (Hoyt, *op. cit.*, 255; Bent. 1939. *U.S. Nat. Mus. Bull.*, 174:164–194). Kilham (1959. *Wilson Bull.*, 71:191) has recently reported observing a black snake that spent five days in a cavity a few feet from a Pileated nest and left without taking the nestlings. The present note describes an apparently fatal attack by a male Pileated Woodpecker on a large black snake which had entered a hollow used by a pair of the birds near Bloomington, Indiana.

The nest at which the incident occurred was 20 feet up in a dead beech (*Fagus grandifolia*) stub 26 feet high, 22 inches dbh, and about 17 inches thick at the level of the entrance to the cavity. The hole in the tree faced west and measured some three inches wide by three and one-half inches high.

About a week prior to May 23, 1958, a male Pileated Woodpecker had been discovered entering the tree, and a day or two later a female went in. Each of the pair was seen going in several more times; and this fact, the date, and the behavior herein reported are the basis for the assumption that there probably was a nest there. The birds did not relieve each other at the cavity, which suggests the possibilities that it contained either an incomplete clutch of eggs or held young being brooded only part of the time. If there were young, however, they were not yet old enough to greet returning parents at the entrance to the nest. Since adults feed nestlings by regurgitation, food-bringing would not have been noticed.

From the hole at 2 p.m. on May 23, there protruded part of a pilot black snake; the posterior two feet or so were visible, and the girth of this segment indicated a total length of a little over five feet. In the next 15 minutes a few more inches of the body moved slowly out of sight. Finally the snake disappeared into the hollow, and shortly thereafter the male woodpecker arrived at the tree, hopped up, looked in, and withdrew his head. To me, 30 yards away and (because the nest stub was on a hill) at eye level, no sound was audible, nor was there any display or other response suggesting alarm or excitement. Instead, the woodpecker began deliberately and methodically to deliver hard blows into the cavity, pausing for from 10 to 60 seconds after each one or two jabs; during these pauses the bird remained in position and looked into the hole or, more rarely, surveyed the surrounding woods. Occasionally the snake could be glimpsed dimly as part of its body passed before the aperture. In the course of 20 minutes, in which some 50 or 60 blows were delivered, the orientation of the woodpecker's attack shifted from the bottom of the hole to a point above the entrance and then back down again. It therefore seemed possible that the blows were aimed at a specific part of the snake, perhaps the head. One or two quick movements by the bird may have been reactions to strikes by the snake; otherwise there was nothing to suggest effective resistance.

About 20 minutes after the male's appearance the female flew to a nearby tree and then landed beside her mate. The male thereupon departed, not to return during the remainder

of the observation. To the last, his behavior seemed free of excitement, and it was soon indicated that probably he had communicated no alarm to the female: she hopped quickly to the entrance and thrust her head well in, then jerked backward so suddenly and violently that she lost her grip and fell away from the tree. Returning immediately, she began constantly to thrust her head in and out of the hole and continued to do so for at least half an hour, at first as often as 30 times a minute. Evidently there was little life remaining in the snake, for gradually the bird left her head in the cavity for longer stretches, finally for 10 seconds at a time. However, even after 30 minutes, when it was necessary to discontinue observation, she was still alternately scrutinizing the contents of the hole and then looking at the woods around her, as though in considerable nervousness. (Probably neither woodpecker ever was aware of my presence.)

Repeated visits to the tree during the days that followed disclosed no Pileated Woodpeckers near it; the nest, if there was one, apparently failed when the snake gained entrance to it. No informative traces could be found on the surrounding ground, but dense vegetation may have hidden the snake's body, even if the woodpeckers removed it and dropped it nearby.

Throughout incubation and early life of nestlings, one member of the pair of Pileated Woodpeckers is virtually always at the nest (Hoyt, *op. cit.*, 251–253), and this was true of the birds observed by Kilham (*op. cit.*). If the behavior described herein is typical and the reaction to a snake entering or attempting to enter the nest is to attack and sometimes overcome it, then nest relief must greatly reduce the risks from this group of predators. In the light of the present observations, it is the more interesting that Kilham should have seen a five-foot black snake making its departure after five days spent harmlessly so near a cavity containing small young.—Val Nolan, Jr., *Indiana University, Bloomington, Indiana, August 12, 1959.*

A North American sight record of the Redwing.—On February 21, 1959, at ca. 10:00 a.m., Messrs. S. Stepinoff, S. Ozard, T. Peszel, J. Kirk, and I discovered a Redwing, *Turdus musicus* (*Turdus iliacus* of some authorities), at the West Impoundment of the Jamaica Bay Wildlife Sanctuary, Ruler's Bar Hassock, Queens County, New York. The Redwing is a Palaearctic thrush not previously reported on the North American mainland, though recorded several times in Greenland (1957. A.O.U. Check-list, 5th ed., p. 430). The bird was observed at distances varying from 20 to 100 feet by means of 10 × 50 binoculars and a 20× spotting telescope. The individual was extremely wary, repeatedly taking flight when efforts at closer approach were made; such molestations having been ceased however, the Redwing was observed to feed on the berries of several shrubs in the area of the sanctuary parking-field. Upon his arrival, Mr. H. Johnson, manager of the sanctuary, was shown the bird. Johnson recalled having seen it in the locality on the previous day, though he had not identified it. During the next two days a large number of observers gathered at the sanctuary, including several familiar with the species in Britain and Europe. The Redwing was last seen on February 24, 1959.

By way of description, I observed the following features on February 21:

Head, wings, back and tail were of a neutral brown-gray color, somewhat broken with light gray on the secondaries and coverts. The face-pattern, consisting of striking white moustachial and superciliary stripes, was unusually bright. The underparts were white, with black streaking on the breast, the flanks and wing-linings possessing the reddish coloration characteristic of the species. The bill was yellow with a black tip, or perhaps a black tip to the upper mandible alone.

Inquiry has failed to locate any cage-bird dealer or zoological collection in the city

dealing in or possessing individuals of this species. Unfortunately, the number of aviculturalists and zoological supply houses in the neighborhood of the metropolis is legion. It is well to note however, that the behavior of the Redwing seemed characteristic of a wild bird, rather than of one accustomed to the proximity of humans.—Charles F. J. Young, *Photographic Service Division, New York Public Library, New York 18, N.Y., April 23, 1959.*

Notes on pairing and nest-building of mismatched vireos.—A study on species relationships in the genus *Vireo* (Hamilton, 1958. *Wilson Bull.*, 70:307–346) analyzes the relationship between the Solitary and Yellow-throated Vireos (*V. solitarius* and *V. flavifrons*). The following notes may be of value to the study of interspecific relationships of these species.

On May 19, 1958, a Yellow-throated Vireo, with something in its bill, flew into a tall post oak in my front yard. The following day I located its nest in the oak on a slender branch which made a downward arc from a larger branch, 25 feet from the ground and 12 feet out from the trunk of the tree.

A vireo was present, working in the nest. This bird had no yellow at the throat or eyes, although wing-bars and a light eye-ring were evident. Careful study of the bird on succeeding visits, and reference to the discussion of vireo plumages in Bent (1950. *U.S. Nat. Mus. Bull.*, 197) and Dwight (1900. *Ann. New York Acad. Sci.*, 13:239), confirmed an early speculation that this bird, a female, was a Solitary Vireo, perhaps of the subspecies known as the Mountain Vireo (*Vireo solitarius alticola*). [Southern Pines, 20 miles west of Fayetteville, is the easternmost known nesting area of the Solitary Vireo in this state (1948. *The Chat*, 12:53).] The bird had a dark head and back, white eye-ring and wing-bars, complete absence of yellow at the throat, but a strong yellow wash at the sides. The throat, breast, and belly were white. On one visit, during a light drizzle, the back appeared slaty-brown. In addition, there was a creamy yellow wash at the crissum (which Dwight stated was limited to juvenal plumage).

The Yellow-throated Vireo, the male of this pair, was in song and present at the nest area most of the time although it was never seen working in or about the nest. Bent (*op. cit.*) records that both sexes of *flavifrons* are assiduous and attentive nest-builders; that the female of *solitarius* "seems to do most of it and to be the dominant influence, the male's part consisting mainly of bringing materials."

The male Yellow-throated Vireo accompanied the female Solitary Vireo on her visits to the nest, perching nearby while she worked at the interior and the rim. Both birds were seen on a number of occasions perched side by side in pine trees in the yard, preening or resting. On May 26 the female Solitary Vireo made nine recorded visits to the nest, the exterior of which appeared complete; the male Yellow-throated Vireo sang more incessantly than on previous days. Twice on this day, I saw the male Yellow-throated Vireo join the female at the nest site. The male displayed, with wings fluttering; the pair copulated briefly only a few inches from the nest. On both of these occasions, the female remained crouched in a begging posture, with wings fluttering, after the male had hopped to a nearby perch.

On May 27, at 7:05 a.m., I saw a Yellow-throated Vireo fly silently to the nest. The bird got in, shaping and arranging the interior and the rim. Since I had never seen the male Yellow-throated Vireo in the nest, I watched carefully after the bird left; at 7:45 a.m. *two* Yellow-throated Vireos flew to the nest site, one perching silently nearby while the other got into the nest to turn and work in it briefly before they both left.

There was no way to determine whether this was an intruding pair of Yellow-throated

Vireos, or whether the male of the original mismatched pair was attracted to a female of his own kind. At 8:05 a.m. the female Solitary Vireo visited the nest alone and worked in it briefly. A Yellow-throated Vireo was perched near the nest, and singing, when the Solitary Vireo returned at 9:10 a.m. and remained to work in the nest for two minutes. The female Solitary Vireo then flew to a neighboring oak to preen in the sun. She stayed within 50 feet of the nest for the following 50 minutes, something I had not seen her do before; she was not joined by her mate. The female Solitary Vireo made a final brief visit to the nest at 10:06 a.m., remaining only a few seconds before flying off for the last time. A Yellow-throated Vireo, perched near the nest, sang as she approached as well as during and after her last visit. The Yellow-throated Vireo did not fly toward, nor threaten, the Solitary Vireo, unless its song, during her visit to her nest, constituted a threat.

Later that morning, I saw a Yellow-throated Vireo at the nest on three separate occasions. Each time the bird got into the nest to turn and shape it; each time it seemed to peck and eat something from the rim; and on each visit the bird sang. Although I did not see two Yellow-throated Vireos in the area at the same time again until several days later, a Yellow-throated Vireo was present and singing through much of the afternoon. A single Yellow-throated Vireo was seen at the nest early the following morning. No other vireos were heard or seen in the area until May 30, when a pair of Yellow-throated Vireos hopped through the branches of a pine tree and then flew toward, but over, the nest tree and out of sight.

A week later I secured the empty nest and sent it to Dr. Herbert G. Deignan at the U.S. National Museum. After comparing the nest with those of a series of Yellow-throated, Solitary, and Mountain Vireos, in company with Dr. Alexander Wetmore, Dr. Deignan wrote:

". . . Your nest distinctly fits with the nests of the two blue-headed races in its greater dimensions, and does not disagree with them in materials. This would seem to show that, while both members of a mated pair of vireos take part in nest-building, it is the female that is responsible for the architecture of the nest. . . ."—Doris C. Hauser, *309 Sylvan Road, Fayetteville, N. C., January 1, 1959.*

Sparrow Hawks attempting to breed in the laboratory.—Sibling Sparrow Hawks (*Falco sparverius*) taken before they could fly, were kept in a cage (6 × 2 × 5 feet high) in the laboratory (temperature 19° to 21°C.—winter; 23° to 28°C.—summer). They were fed white rats and mice, horse meat and wild birds.

In March, nearly a year after hatching, a pasteboard box with a hole 5 × 6 inches in the side was fastened in the upper corner of the cage. The birds soon enlarged the hole. On April 30 an egg was laid but disappeared the next morning. Five days later a second egg was found but was broken a few hours later. A third egg, laid seven days after the first, remained for 19 days when it was broken. No more eggs were laid.

In late February of the following year the female became very active trying to push the male along the perch and pecking him without response. A few days later (March 8) copulation started. During the height of their sexual activity copulation was frequent. For example, on March 15 they copulated 14 times from 7 a.m. to 7:36 a.m.; six times more before noon and once more at 4:50 p.m. The female was the aggressor. As the season advanced sexual activity diminished, so that by early May copulation occurred only once or twice a day and then ceased. Four eggs were laid but all were broken soon afterwards.

The female died at 30 months of age, having eaten a bird that may have been infected. She was replaced by another female a few months old. At first the newcomer became so aggressive that a few days' separation was necessary. Shortly after the female was returned

to the large cage the male attempted copulation but the female was not receptive until the latter part of March when copulation became frequent. On May 6 the first egg was laid but soon was broken. By the time a sixth egg (May 25) had been laid the female was setting much of the time, the male replacing her occasionally. None of the eggs hatched.

Each year the birds began to show an interest in the nest box during the last days of February and did a little courting. Laying began about the middle of April and continued into May until five or six eggs had been laid. In one season, of three eggs which remained unbroken, one was not fertile but the other two contained embryos. None ever hatched.

At 86 months of age the male died of encephalitis. The remaining female survived five years more, dying at the age of 115 months. A year before this she began to refuse all food but white mice, although she appeared in good condition. A week before death, her appetite began to fail and she would sit on her perch with eyes closed. An autopsy was performed but no pathology was found. —Frank A. Hartman, *Department of Physiology, The Ohio State University, Columbus, Ohio, December 15, 1958.*

Chipping Sparrow copulates with House Sparrow.—On the afternoon of July 17, 1959, an adult male House Sparrow (*Passer domesticus*) was feeding approximately 15 feet from a small Scotch pine in Kalamazoo, Michigan. This tree contained a nest of a pair of Chipping Sparrows (*Spizella passerina*), in which was one young bird. One of the Chipping Sparrows, a male judging from its bright rufous crown, flew from the tree and alighted, facing the House Sparrow and some two feet from it. The House Sparrow, with partially extended wings and upturned bill, immediately hopped toward the Chipping Sparrow in the attitude usually associated with food-begging by young House Sparrows. The Chipping Sparrow retreated approximately one foot from the advancing House Sparrow, then turned and advanced toward it. While the House Sparrow was still crouched with partially extended wings, the Chipping Sparrow hopped to its side, mounted the now passive bird and attempted copulation. I could not ascertain if actual cloacal contact was achieved. No longer than four seconds passed from the time the Chipping Sparrow mounted until it fluttered off and returned to the nest tree. The House Sparrow, after approximately 30 seconds, flew to a nearby building.—Thane S. Robinson, *Department of Biology, Western Michigan University, Kalamazoo, Michigan, August 7, 1959.*

Caspian Tern and Black Skimmer in Newfoundland.—On July 10, 1958, Tordoff and an ornithology class from the University of Michigan Biological Station found a single pair of Caspian Terns (*Hydroprogne caspia*) nesting in a large colony of Ring-billed Gulls (*Larus delawarensis*) at Rogers City, Presque Isle County, Michigan. These terns very likely were the same individuals found nesting there in 1957 (Pettingill, 1958. *Jack-Pine Warbler*, 183–184). With the adult terns we found two large young capable of short flights. We captured and banded (FWS 566-32953) one of the young.

On September 30, 1958, this tern was shot by Mr. Edwin Keeping at Boxey, Fortune Bay, Newfoundland. Southern wrote to Keeping to confirm the information received from the U. S. Fish and Wildlife Service Bird Banding Office. The recovery date sent to us by this office was October 9, which seems to be the date the report was received rather than the date the bird was taken. In addition to supplying details on the tern, Mr. Keeping also sent to us for identification part of another bird—the bill and anterior part of the crown and face of a Black Skimmer (*Rynchops nigra*), probably a male judging by bill size. Keeping had taken the skimmer at Boxey on September 30, 1958. The specimen has been sent to the National Museum of Canada for permanent preservation.

The Caspian Tern is an "uncommon summer resident" in Newfoundland and probably

breeds in the Fortune Bay area (Peters and Burleigh, 1951. "The Birds of Newfoundland"), but the northeastward journey of our banded bird is noteworthy. It is possible, of course, that the tern was carried to Newfoundland from some coastal point to the south by 1958's hurricane Helene. The Black Skimmer, judging by records available for the Fifth Edition (1957) of the A.O.U. Check-list, has not been reported previously from this province. However, W. Earl Godfrey informs us that over two dozen Black Skimmers were seen alive or found dead in Newfoundland in late September and early October, 1958, displaced victims of the same hurricane Helene.—Harrison B. Tordoff and William E. Southern, *The University of Michigan Museum of Zoology, Ann Arbor, Michigan, August 20, 1959.*

Notes on a late nesting of Harris' Hawks near Midland, Texas.—The A. O. U. "Check-list of North American Birds," (5th ed.) 1957, gives the following southern resident ranges for the two subspecies of Harris' Hawk (*Parabuteo unicinctus*): (1) *P. u. harrisi*: from southern Texas (Eagle Pass, San Antonio, Giddings) south into Mexico, etc. (2) *P. u. superior*: from southeastern California, Arizona, and southern New Mexico (Carlsbad) south to Baja California, Sonora and Sinaloa. Neither of these ranges includes Midland, Texas, which is on the southern edge of the Llano Estacado, approximately 300 miles north and west of Eagle Pass and 200 miles east of Carlsbad.

Since the winter of 1956–1957, Harris' Hawks have been observed continuously on the Clarence Scharbauer "South Curtis" ranch, three miles north of the city limits of Midland. No observations were made on the ranch prior to that winter and no nest that could be attributed to that species was found prior to 1958.

On October 1, 1958, an adult Harris' Hawk was flushed from a nest in a soapberry (*Sapindus saponaria*) grove at a water tank supplied by windmill, 2.2 miles north of the ranch house. The down-covered head of one young was seen at the edge of the nest. A young bird had been heard calling from the nest on September 23 and 26, but on neither day was an adult bird seen. On October 6, the young hawk was able to stand in the nest and, from a continuous up and down movement of the head, was either preening itself or feeding on something in the nest. On October 8, there were two down-covered young in the nest. On that date, and again on October 9, we flushed the adult from the nest at a distance of about ¾ mile.

The nest was approximately 15 to 18 feet above ground near the top of a soapberry tree, placed in the bend of one upright limb, and supported by another limb. The tree was 10 inches DBH. The nest was about two to two and one-half feet in diameter, and made on the outside of thick twigs and branches from soapberry, mesquite (*Prosopis juliflora*) and hackberry (*Celtis laevigata*), all of which were readily accessible to the nest site. The only food items seen near the nest were rabbits, including one full-grown rabbit and assorted parts.

From October 10 to 19, the road to the nest was impassable because of mud. On the 19th, the adult flushed at ¾ mile. Both young were well down in the nest with only their heads visible. The heads were almost feathered, though some down could be seen. On October 20, one of the young was standing on the edge of the nest. The wings seemed to be completely feathered; the head almost feathered, with some down feathers remaining; and the breast buffy with brown to black streaks. Both young were standing on the nest on October 21, and one appeared slightly older than the other. Two adult hawks were in the grove, and three adults were elsewhere on the ranch. On the 22nd, there was a definite white band seen at the end of the tail of the older young. Before this date, the tails had not been seen. The adult hawk flushed from the nest at a distance of about 100 yards on October 23 and flew only a short way into the grove.

The first young left the nest either late on October 23 or early October 24. On the 24th, it was found in a tree about 20 yards from the nest and alternately flew and hopped until it had returned to the tree nearest the nest tree.

Rain again made the road impassable from October 24 to November 6, but we walked to the grove from the nearest paved road on October 30. There were two adults soaring near the grove and one bird on the nest. Whether it was an adult or an immature could not be determined, since it was well down in the nest with only its back visible. On November 6, three Harris' Hawks were flushed from the windmill about 200 yards from the nest. Two were mature, but the third disappeared into the grove before it could be seen well. One young hawk was standing on the side of the nest. It made no effort to fly, and its craw seemed to be full—as it was on every occasion when the breasts of the young hawks could be seen, though trips to the nest were made at various times of day between 9 a.m. and 3 p.m.

On November 10, two adult hawks and one immature were in the east side of the grove about 300 yards from the nest. The other young hawk was standing on the edge of the nest. Its wings, head and tail appeared fully feathered; its breast was still very streaked. It left the nest either late on November 10 or early on November 11, and both young hawks were found in the grove on November 11. One called from a tree about 50 yards from the nest and then flew reasonably well. The tail and upper sides of the wings had an adult appearance. The breast was still quite streaked and the undersides of the wings were lighter in color than the adult underwing, with less differentiation between the color of the flight feathers and that of the wing linings.

Both immatures were still in the grove on November 13, but were not found again until December 21, when they and two adults were at a tank .7 mile from the grove. On December 31, two adults and two immatures were seen in the grove, and a group of four was seen on January 7, 1959, about three miles from the grove.

Bent (1937. *U. S. Nat. Mus. Bull.* no. 167) gives the latest egg dates for Harris' Hawks as June 21 (p. 147). The incubation period is "said to be 4 weeks" (p. 143), but no reference is made to any known nest. If that incubation period is correct, these eggs must have been laid on or about August 25, two months later than any eggs noted in Bent. No reference to later egg dates has been located elsewhere, and correspondence with several residents of south Texas has produced no later dates.—Anne L. LeSassier, *1611 W. Indiana, Midland, Texas,* and Frances C. Williams, *c/o City Carrier 102, Midland, Texas, January 27, 1959.*

Laughing Gulls following the plow.—It has long been known that several members of the genus *Larus* throughout the world habitually feed in soil turned up by a plow. This practice has been associated with such insect-eating gulls as Franklin's Gull (*L. pipixcan*), Ring-billed Gull (*L. delawarensis*), California Gull (*L. californicus*), Black-headed Gull (*L. ridibundus*), Lesser Black-backed Gull (*L. fuscus*), Mew Gull (*L. canus*), and others. (See, e.g., Bent, 1921, "Life Histories of North American Gulls and Terns," Washington; and Witherby, *et al.*, 1944, "The Handbook of British Birds," Volume V, London.)

To my knowledge, this has never been recorded for the Laughing Gull (*L. atricilla*), except for a brief reference to Laughing Gulls ". . . seen . . . scattered over . . . newly-ploughed fields, regaling on . . . worms, insects, and their larvae . . ." by Wilson (Brewer, 1854. "Wilson's American Ornithology." New York). However, no reference was made here to the act of following the plow in operation.

At various times between April and July of 1955 and 1956, I frequently observed Laughing Gulls following plows on the eastern shore of Maryland and Virginia. These were

noted most often in the Sinepuxent area south of Ocean City, Worcester County, Maryland, and near Exmore, Northampton County, Virginia.

The Laughing Gull, a common nesting bird here, is rather closely associated with the seacoast and rarely strays inland when feeding. However, in this area, where farm land often adjoins the sea, this species could easily come into contact with farm land being plowed, and with other gull species following the plow. This provides a situation where learning can take place.

This learning process is not as difficult as might be supposed, for these gulls, as well as others, commonly investigate passing boats and follow those which throw off scrap fish and other food. It would not take long for a gull to learn to follow an object, in this case a plowing tractor, especially if other gulls are already feeding behind it. According to the observations of Frings, *et al.* (1955. *Wilson Bull.*, 67:155–170), on Herring Gulls (*L. argentatus*), at least some gulls are stimulated by sight and sound to investigate a group of feeding gulls.—Robert G. Wolk, *Department of Biology, St. Lawrence University, Canton, New York, March 3, 1959.*

NEW LIFE MEMBER

Mrs. Chandler Robbins II, a busy house wife at Eastern Point, Gloucester, Massachusetts, finds time to pursue her natural history interests in several ways. She is a volunteer associate of the Natural History Department of the Peabody Museum, and participates in the banding of pelagic birds off the coast of Cape Ann, Massachusetts.

Since her graduation from Bryn Mawr College, Mrs. Robbins has written several articles for *Massachusetts Audubon*, has been elected a director of that society, and has become a member of the A. O. U.—all in addition to raising five teen-age children.

ORNITHOLOGICAL NEWS

We are pleased to announce that Dr. R. M. Strong, a Founder and Past President of the Wilson Ornithological Society, has been named our fourth Patron through the gift of an anonymous donor.

It is indeed a pleasure for me, especially as a neophyte editor, to take this opportunity to express my sincere appreciation to members of the editorial board—George A. Bartholomew, Andrew J. Berger, William W. H. Gunn, William A. Lunk, Robert A. Norris, Kenneth C. Parkes, Raymond A. Paynter, Jr.—and to H. Albert Hochbaum and O. S. Pettingill, Jr., for their excellent cooperation in critically, seriously, and promptly reviewing material intended for publication in the *Bulletin*.—H.L.B.

From the A. O. U.

Notice has been received of the following results of elections at the August meeting (77th stated) of the A. O. U. at Regina, Saskatchewan: President, George H. Lowery, Jr.; First Vice-President, Dean Amadon; Second Vice-President, Austin L. Rand; Treasurer, Charles G. Sibley; Secretary, Herbert G. Deignan; Class of Fellows—John Davis, Thomas R. Howell, A. Starker Leopold; Class of Elective Members—H. Lewis Batts, Jr., Pershing B. Hofslund, C. Stuart Houston, Richard F. Johnston, Martin H. Moynihan, Robert K. Selander; Corresponding Fellows—F. W. Merkel (Germany), Derek Goodwin (Great Britain), Frantiček Turček (Czechoslovakia), V. C. Wynne-Edwards (Great Britain); Editor of *The Auk*, Donald S. Farner.

The Brewster Memorial Award went to Alexander Wetmore for more than 50 years of distinguished work in avian paleontology and systematic ornithology.

The 1960 meetings will take place in Ann Arbor, Michigan, from August 23 to 26.

The Rockbridge Alum Springs Biological Laboratory will soon be open for research students or others interested in working in the several branches of the natural sciences. A number of experimental field research projects have been going on for several years during building construction, and during the packing and removal of specimens and library from Florida to Virginia.

W. O. S. members who are capably interested in entomology, forestry, horticulture, or the practical and working side of conservation, and who are desirous of a paying position may write to Harold H. Bailey, c/o the laboratory, Route 2, Goshen, Virginia, for further information.

The Division of Biological and Medical Sciences of the National Science Foundation announces that the next closing date for receipt of basic research proposals in the Life Sciences is January 15, 1960. Proposals received prior to that date will be reviewed at the the spring meetings of the Foundation's advisory panels, and disposition will be made approximately four months following the closing date. Proposals received after the January 15, 1960 closing date will be reviewed following the summer closing date of May 15, 1960. Inquiries should be addressed to the National Science Foundation, Washington 25, D. C.

JOSSELYN VAN TYNE MEMORIAL LIBRARY

The following gifts have been recently received. From:

Arthur E. Aronoff—1 reprint
H. Lewis Batts, Jr.—4 journals, 1 reprint
Donald E. Burton—1 journal
Peter S. Chrapliwy—7 reprints
W. Powell Cottrille—3 journals
Jack P. Hailman—1 reprint
Bette J. Johnston—1 book
Peter H. Klopfer—4 reprints
Harold F. Mayfield—6 journals, 27 reprints
University of Michigan Museum of Zoology—12 reprints, 2 occasional papers
Margaret M. Nice—2 journals, 26 reprints
Walter P. Nickell—1 reprint
D. F. Owen—2 journals, 6 reprints
Peabody Museum—2 journals, 1 reprint
O. S. Pettingill, Jr.—7 reprints
University of Puerto Rico—9 reprints
William B. Robertson, Jr.—6 reprints, 2 pamphlets
Rose Lake Wildlife Experimental Station—1 reprint
Aretas A. Saunders—2 books
W. E. Scott—4 reprints, 9 pamphlets
Charles G. Sibley—6 reprints
P. Stettenheim—1 journal, 1 reprint
Robert W. Storer—1 pamphlet
Syracuse University College of Forestry—37 reprints
Harrison B. Tordoff—3 reprints
Mrs. Josselyn Van Tyne—130 books, 200 reprints
Wisconsin Conservation Department—1 pamphlet
Wisconsin Society for Ornithology—15 reprints
H. E. Wolters—2 reprints

A correction: Through an unfortunate error the contribution of 66 journals to the Josselyn Van Tyne Memorial Library by Mr. John Willoughby was reported in the March, 1959, donor list as being by "George Willoughby." Our apologies, and again our appreciation, to Mr. Willoughby.

ORNITHOLOGICAL LITERATURE

FUNDAMENTALS OF ORNITHOLOGY. By Josselyn Van Tyne and Andrew J. Berger. John Wiley & Sons, Inc., New York, 1959: 6 × 9¼ in., xii + 624 pp., 252 illus. $11.75.

Josselyn Van Tyne had been disturbed for many years about the lack of a good English-language *Ornithology*. The available texts, although each had certain virtues, were either out of date, too much devoted to applied biology (at the expense of the "science of birds"), too superficial, or, worse yet, full of mistakes. There was not a single volume one could recommend with good conscience to a student without warning him of these shortcomings. This gap in our literature he set out to fill. When Van Tyne resigned as Editor of *The Wilson Bulletin* in 1948 he already had extensive notes, and from then on he worked on the text with that painstaking attention to detail so characteristic of him. Alas, at the time of his death in January, 1957, the manuscript was not even half completed. American ornithology owes a tremendous debt of gratitude to A. J. Berger for putting aside all of his own projects in order to complete the work. Van Tyne could not have made a better choice in his collaborator, for Berger has an interest in and understanding of many diverse branches of ornithology, ranging from anatomy to behavior. The result of the collaboration is a volume of which a pre-publication reviewer has said, "I have little doubt that Van Tyne and Berger will be adopted for practically all college courses in ornithology and will also be a most useful reference for both amateur and professional ornithologists." I fully endorse this evaluation. This is a far superior volume to anything else available in the English language.

Josselyn Van Tyne was always a severe critic and of nothing more critical than of his own efforts. In a critical analysis of "Fundamentals" which the editors of *The Wilson Bulletin* asked me to undertake, I have been trying to live up to the standards set by Van Tyne. I will first give a chapter-by-chapter analysis, to be followed by a more general summary.

Chapter one is an excellent and thoroughly up-to-date treatment of fossil birds. The essential characters of the extinct types are recorded, their ecology and possible relation to modern types are discussed, but it is not mentioned how little paleornithology has added to our knowledge of avian relationships.

Chapter two, devoted to avian anatomy, is a competent presentation of the major anatomical features, thoroughly incorporating the modern literature. It contains a wealth of detail on the anatomical variation found in the various groups of birds. The treatment, on the whole, is static and descriptive and only rarely is an effort made to indicate the meaning of the differences from mammals and reptiles and the functional significance of the differences between the various families and orders of birds. A few more illustrations in this chapter would have been useful, as, for instance, one indicating the circulation of air through lungs and air sacs. There is a helpful survey of the characters generally used in avian classification. The definitions of these characters are widely scattered in the literature, and it is convenient to have them in one place. This is true, even though, as Van Tyne and Berger realized, most of these characters have far less phyletic value than claimed in the literature. Indeed, most of them may be quite valueless as indicators of relationship.

The chapter on plumage and molt is, on the whole, excellent and very informative. I myself have learned quite a few new facts from this chapter. The theorizing is, however, often shaky. The phylogenetic sequence of feather types (page 71) is certainly not generally accepted. Personally, I find very persuasive the arguments of those who, like Portmann, demonstrate that all downy feathers are secondary derivations. The dogmatic

statement of a steady reduction in the number of flight feathers (page 84) is rather questionable. Actually, the high number of secondaries in albatrosses and condors appears as much of an evolutionary advance as the reduction in the primaries among the nine-primaried birds. Having so many secondaries does not make condors and albatrosses particularly primitive. The section on bird pigments is rather poor. The interesting, unanalyzed pigments of parrots, one of which is fluorescent, are not mentioned. The section on structural colors is disorganized. What do erythrism and schizochroism do in this section? The cited explanation for iridescence is obsolete (Schmidt, Dorst).

The chapter on senses and behavior must have been the hardest chapter to write. There are so many conflicting theories and methods of approach that a synthesis would have been difficult; it was not attempted. The part on the sense organs is straightforward, but stresses anatomy too much at the expense of the senses which these organs serve. No clear picture of avian vision or hearing emerges. In the behavior part, I thought that the restricted definition of intelligence was most vulnerable.

The chapter on voice and sound production is perhaps the most original one of the volume. It is written with an evident love for the subject and brings together much scattered and hard-to-get-at information. It will surely stimulate work in this area.

Chapter six on the distribution of birds, by contrast, lacks originality and homogeneity. Zoogeography is a controversial field, and continuity of thought and consistency is lost if one wants to do right by everybody. The result is an uneven treatment. Griscom's obsolete idea that the composition of the Guatemalan birdlife is essentially a matter of glacial and post-glacial migrations is quoted approvingly (page 166), while the effects of the late Pliocene closing of the Panama gap are not mentioned. Some of the most interesting zoogeographic phenomena, such as rapid range expansions and the mixing of the North and South American fauna in Central America, are not adequately treated, while the cyclical irruptions of northern birds are treated in this chapter rather than under migrations.

An adequate treatment of the large and complex subject of bird migration in a single chapter is virtually impossible. The authors have done very well in the available space. In the section on the causes of migration, I would have liked to see a clearer separation of ultimate (selective) and proximate (physiological mechanisms) factors. In the physiology of migration, more stress should have been placed on the differences in the control mechanisms among species. Witness the difference in the control of the annual cycle of the juncos, the Emperor Penguin, and the Australian Mutton-bird. The failure in bringing previously completed chapters up to date has marred this chapter more than any other. Neither Sutter's radar observations nor Sauer's stellar navigation nor Kramer's rebuttal of Matthews' theory of homing are even mentioned. Instead, much space is given to some thoroughly discredited work. Stresemann's unique work on an annual calendar of migration is not mentioned.

Since this chapter cannot possibly give an anywhere near complete account of migration, it would have been useful to recommend a few books on the subject, for additional reading, in addition to the detailed bibliography of specialized literature.

I found chapter eight, on bird flight, rather chaotic. No clear picture of the aerodynamics of flight emerges. Important aspects, such as landing, starting, and dynamic soaring, are hardly mentioned. The emphasis in the chapter is on the equipment rather than on flight.

The chapter on food and feeding habits is informative and original. The choice from the enormous potential literature is well done. There is no excuse, however, for not incorporating into the text Schmidt-Nielsen's recent discovery of the salt glands.

Chapter 10 on breeding behavior is a well-balanced survey of this enormous field. The treatment in some areas is one-sided, such as the neglect of hole-nesting birds (with respect to territory and nest site selection), age at breeding (*Zosterops*, *Coturnix*, *Streptopelia*), size of eggs, special adaptation of tropical birds, etc. In the discussion of the "initiation of the breeding season," the treatment suffers, as in migration, from a failure of separating proximate and ultimate factors. Though numerous facts are presented, they do not lead to any generalizations.

Chapter 11 deals with social relations, a subject usually neglected by ornithologists. It is a useful survey of this subject, even though one could quibble over some of the details of treatment. Sladen's finding that adult penguins continue to recognize their young in the creches should have been mentioned.

Chapter 12 is a good summary of modern taxonomic ideas. Even controversial subjects are presented objectively and with good taste. There are some minor errors. For instance, *Dicrurus hottentottus* (page 363) is not an example of individual but of geographic variation.

Chapter 13 (with 177 pages) is by far the largest chapter of the book. It attempts to give the most important information on every one of the families of birds as recognized by the authors. The essential information on physical characteristics, geographic range, habits, food, and breeding habits are presented in about 20 lines. A single page is devoted to each family. The resulting consistency and ease of reference is bought at a price. Families with 328, 365, 375, and 398 species get no more space than the more than 20 families with a single species each. There is remarkably little consistency as to the recognition of families. Monotypic genera, such as *Leptosoma*, *Cochlearius*, *Oxyruncus*, *Zeledonia*, *Dulus*, *Tersina*, and *Catamblyrhynchus*, are recognized as families (as well as the Cyclarhidae and Vireolaniidae), a procedure which, although definitely defensible, would indicate a standard of fine splitting; and yet *Rupicola* is included in the Cotingidae; the Panuridae, Paradoxornithidae, Chamaeidae, and Cinclosomatidae are combined with the Timaliidae; the Pachycephalidae and Monarchinae are combined with the Muscicapidae; and worst of all, the Carduelidae are lumped with the Ploceidae; the Estrildidae are not even mentioned. All this indicates extreme lumping. Such unequal standards of family recognition must be confusing to the student. The literature references under the families are on the whole well chosen and cover the world literature, although the selection could have been better in a few families (e.g., Strigidae).

The extreme shortness of the accounts forced the authors to ignore some of the most interesting attributes of these families, particularly those concerning biology and physiology. Nothing is said on the metabolism of hummingbirds, torpidity in the Caprimulgidae, variation in parasitic habits in cuckoos, display patterns and parental care in ducks, etc. The technical diagnosis is copied from the standard literature.

Some of the special features of the volume should be pointed out. The bibliography is an extremely good introduction to the modern ornithological literature. The chapter bibliographies total 46 pages, listing about 1,300 titles. In addition, there are six pages dealing with encyclopedic and bibliographic sources, which will facilitate a further access to the literature. To be sure, the student in a small college may find only a fraction of this available to him, but at least he knows that there is more and where he can find it. Much of the literature listed at the conclusion of chapters is not utilized in the preceding text of the chapters.

There is an extensive glossary (28 pages) which could have been shorter, if some rather self-evident terms had been omitted, as, for instance, under *A*: aberrant. acute, anomalous, anterior, aquatic, arboreal, etc. Some of the terms (e.g., biome) are defined

incorrectly. The definition of the arm as the "region between the shoulder and the elbow" is peculiar to anatomists.

The proofreading has been outstandingly good. I have found only a single evident misprint. Some minor errors, e.g., misspellings for *Phonygammus, Stingelin, Bathmocercus, Regenruf, Xenophon, Lavauden*, etc., seem to be rather slips of the pen. It is a pity that the scientific names were not scrutinized by a specialist. Such inconsistencies could have been avoided as *Tchitrea* (295) for *Terpsiphone* (366, 526), *Totanus* (204, 268, 366) for *Tringa* (135), *Capella* (86, 133, 336) for *Gallinago* (112), *Charadrius* (207) for *Pluvialis* (193, 284), *Dissemurus* (304) for *Dicrurus* (505), *Grallina picata* (509) for *G. cyanoleuca* (135), *Graucalus* (504) for *Coracina* (504), *Laiscopus* (527) for *Prunella* (527), and *Gennaeus* (86) for *Lophura* (73, 421). *Muscadivores* (239) is now called *Ducula*, and *Pygoscelis adeliae* (258) is the correct spelling. The index is full and has guided me quickly to all items I was looking for. I find the absence of authors' names in the index no handicap.

Having completed the consideration of all this detail, we can now weigh the virtues and deficiencies of "Fundamentals of Ornithology." It is a volume of great competence and good balance. Containing but few outright errors, it is a volume one can rely on. It is written simply and clearly with a minimum of jargon except for descriptive anatomical terms. There is a consistent endeavor to lead the student from the very beginning to more advanced topics. Styling, typography, and proofreading are excellent. The illustrations are well chosen, and George M. Sutton's black and white drawings of representatives of 168 families of birds greatly add to the attractivenes of the the volume. The world literature is made available to the student to an unusual degree.

I have two major criticisms. One is that the volume attempts to cover too broad an area in a single volume. We know so much about birds, with thousands of workers everywhere writing monographs and research papers, that a truly up-to-date treatment of almost any subject would have to go far beyond what is included in "Fundamentals." This is particularly true for chapter 13 where the treatment is quite sketchy for most families. I wonder whether it would not be better, in a revision, to eliminate the survey of the avian families, publish it separately, and use the 177 pages gained thereby to permit a fuller treatment in the remaining 12 chapters. Van Tyne had planned the volume for the graduate student, but as it is now before us, it would seem to be closer to the undergraduate level, as also remarked by Friedmann in his review in *Science*.

My other criticism concerns the treatment as such. It is very competent, very scholarly, yet it is largely descriptive. The study of birds has to touch on so many intensely exciting things in avian biology, such as flight adaptations, control of the annual cycle, orientation, but these topics are treated in the volume with the same dryness and aloofness as the details of the skeleton. Nor is the student being made aware sufficiently of the numerous interrelations between function, habit, and structure. The biology of the bird almost invariably takes second place to the description of its structure. Little advantage has been taken of controversial subjects to excite the student. Objectivity is priced above all. Its very value as a reference work diminishes its usefulness as an exciting introduction into the life of birds.

A reviewer once said that a book could be looked at in two ways, what it is and what it could have been. It should be evident from my review that I have full praise for "Fundamentals" for what it is. It is by a considerable margin the best English-language college text in ornithology; indeed it is the best Ornithology in any language (excluding the handbooks of Stresemann and Grassé). Yet as a conscientious reviewer, I cannot conceal my feeling that there is still abundant room for improvement.—Ernst Mayr.

THE BIRDS OF ALASKA. By Ira N. Gabrielson and Frederick C. Lincoln. The Stackpole Company, Harrisburg, Pennsylvania, and the Wildlife Management Institute, Washington, D. C., 1959: xiv + 922 pp., 13 colored plates by Olaus J. Murie and Edwin R. Kalmbach, 1 fig., 1 map. $15.00.

Publication of this volume, appropriately coinciding with Alaska's rise to statehood, provides ornithologists with one of the most useful regional works on any section of North America. A great amount of distributional material has been collated by the authors. Previously published records are nicely summarized and many heretofore unpublished data are made available. The book undoubtedly will stimulate further ornithological activity in the new state.

The first 30 pages are devoted to an informative discussion of Alaskan ornithological history, beginning with the early Russian period and continuing through the "Modern Period" to 1958. This section is followed by "Some Interesting Aspects of Alaskan Ornithology" (seven pages), dealing in part with a brief analysis of the avifauna. Here we are informed that the state list consists of 321 species (or 414 species and subspecies), of which only 162 species (233 forms) are "land birds." Nine species included in the book are not discussed in field guides or other works dealing with North American birds. Three of these, the Common Crane (*Grus grus*), Gray-spotted Flycatcher (*Hemichelidon griseisticta*), and Gray-headed Thrush (*Turdus obscurus*) are recent additions not included in the fifth edition of the A.O.U. Check-List. Casual or accidental forms total 104, and 56 of these are Old World birds. Of the 13 forms termed "regular migrants" (not known to nest in Alaska), the authors list only one land bird, *Acanthis flammea holboellii*. They consider 174 forms to be permanent residents. The list of summer residents, including "a few species whose nests have not been actually found but which are almost certain to be breeders—consist[s] of 132 forms of water birds and 189 forms of land birds." However, the next statement tells us that the "total reported in this book is 306 forms of summer resident birds." The number of summer resident *species* is not given, and I find no statement of the number of forms or species positively known to breed in the state. Addition of the figures for these four categories (permanent residents, summer residents, regular migrants, and accidentals) results in 597 forms—183 more than the state's total as previously given in the text (and also in Tables I and II)!

A discussion of the highly plastic Rock Ptarmigan, Winter Wren, Fox Sparrow, and Song Sparrow terminates this section. This provides a concise summary of the trends of variation within these species, but the treatment of possible causative factors is very superficial. Some material is later dealt with in the species accounts and its repetition seems unnecessary.

The next few pages deal wth Alaskan bird migration in terms of Lincoln's flyway theory. Alaska is considered to be the "northern terminus of routes that belong to all four of the major systems" insofar as migratory waterfowl are concerned. Also treated in some detail are four "more or less unique" Alaskan migration routes: (1) an Arctic route from the Alaska Peninsula and Bering Sea islands north along the coast past Point Barrow to the breeding grounds near the Arctic Ocean, (2) an inland route from Norton Sound northeast to the Colville River and the arctic coast, (3) the Asiatic route, presumably along the Siberian coast and across Bering Strait to the Seward Peninsula (used by "North American" birds such as Sandhill Cranes and Gray-cheeked Thrushes which breed in Siberia, and by the Rufous-necked Sandpiper, Bluethroat, Yellow Wagtail, Kennicott's Arctic Warbler, and other "Asiatic" birds nesting in northern Alaska), (4) the Pacific oceanic route, traversed by certain shorebirds that breed in Alaska and winter in Hawaii and other South Pacific islands.

Alaskan ecological zones then are discussed in terms of Merriam's "life zones," of which three occur in Alaska: Arctic-Alpine (coinciding with distribution of Arctic tundra—largely north of the Brooks Range and along the Bering Sea), the Hudsonian (occupying the interior valleys plus "narrow belts around all mountains"), and the Canadian Zone (restricted to a narrow coastal strip in southeastern Alaska). More space is devoted to Nelson's concept of "faunal districts," namely the Sitkan (corresponding to Merriam's Canadian Zone), the Aleutian (southwestern Kodiak Island, the Aleutians, and Pribilofs), the Alaskan (a strip from the Alaska Peninsula along Bristol Bay, Bering Sea, and the Arctic Ocean and including all islands north of the Pribilofs), and the Alaskan-Canadian (coinciding with the Hudsonian Zone of Merriam).

Nearly 800 of the 922 pages in this heavy volume are devoted to the species accounts. The detailed descriptions of birds are "adapted or taken verbatim" from various standard works—Alexander's *Birds of the Ocean*, Bailey's *Handbook of Birds of the Western United States*, Bent's "Life History" series, Ridgway's and Friedmann's *Birds of North and Middle America*, and others. They will be useful to workers who lack extensive libraries or who prefer not to carry several bulky volumes into the field. There is no section on field recognition although this topic is occasionally dealt with under other headings. The General Range paragraphs have been condensed from the fifth edition of the A.O.U. Check-list of North American Birds. The important Alaskan Range accounts (for each species or, in the case of a polytypic species, each race) have been based on numerous sources, particularly the card files maintained by the U.S. Fish and Wildlife Service and unpublished reports from hundreds of observers.

Some of the Haunts and Habits sections contain much useful information—particularly the accounts of species with which Gabrielson has had extensive Alaskan experience. Considerable material is taken from Bent's works and other publications. At times the reader is startled upon encountering anthropomorphic phrases or sentences which are out of place and contribute nothing worth while. There are too many careless statements, some of which require re-reading before their meaning is evident. Others are not clear even then. For example, under Sylviidae, on page 676, appears the statement, "Six species or subspecies have been recorded in Alaska." One must himself count the forms, page by page, to learn that four species and two additional subspecies of this family are on the state list. Numerous paragraphs are unnecessarily long owing to poorly worded sentences and repetition of details already discussed in the descriptions. There is a separate hypothetical list at the end of the book but the same information is given in footnotes for some of these species near their regular taxonomic position. Better organization and more careful editing of the Haunts and Habits material surely would have reduced the number of pages in the volume.

Nomenclature generally follows that of the A.O.U. Check-list, but notable departures include recognition of *Riparia riparia maximilliani* (Stejneger), *Leucosticte tephrocotis kadiaka* (McGregor), and *Passerculus sandwichensis crassus* Peters and Griscom. The authors have assigned all Alaskan Gray Jays to *Perisoreus canadensis arcus*, rather than to *P. c. pacificus*, with no comment or apparent reason for their action. They also consider *Anas carolinensis* conspecific with *A. crecca*.

Vernacular names are applied to subspecies throughout the book, and no overall specific name is provided for polytypic species. This surely will confuse the already befuddled amateur who has tolerated too many haphazard changes in "common" names during the past decade. In the introductory sections one notes such names as Thayer's Gull, Green-throated Loon, and Lapland Longspur which do not appear again in the book. Some of these, listed later on as Thayer's Herring Gull or Green-throated Arctic Loon cause only temporary difficulty, but the reader cannot determine from this book that the Alaska and Lapland

Longspurs are one and the same. There are numerous other examples. *Anas crecca*, here including *A. carolinensis*, is called European Teal on page 31, Common Teal on page 159, and Green-winged Teal on page 285. The main account of *Hylocichla ustulata* is under the name of Swainson's Thrush, but there are at least two references to "Olivebacked" Thrush (pages 285 and 537). Names of this type sometimes are hyphenated on one page but not on another. A lack of consistency is likewise noted in use of the possessive in numerous vernaculars formed from men's names, e.g., Sabine Gull on page 23 but Sabine's Gull on page 462. Even the use of capital letters in bird names is not uniform.

If one considers the total number of words, there are few typographical errors in the book. However, I noted at least 13, two of which have resulted in the misspelling of ornithologists' names. In addition, several bird names are incorrectly spelled: *Picoïdes* appears without the umlaut mark, the race *arcticola* of the Horned Lark is spelled "*articola*," and *Oporornis* appears as "*Oporonis*." Holboell's Redpoll is misspelled "Holbell's" (on page 30) and MacGillivray's Warbler is incorrectly written with a lower case "g." On the poorly labelled "topography of a bird" drawing (page 52) the tail feathers are called "retrices"; the crown, pileum, and occiput are evidently considered synonymous as are bill and culmen! One would further assume from this picture that *nares* is a singular word, and that the term *scapulars* includes all of the upper wing coverts.

The other illustrations are not in keeping with the scope and importance of the book. There are no photographs and the single small map is inadequate. The color plates, depicting 52 species, are poorly reproduced—a trait seemingly characteristic of many recently published American bird books. In my copy three plates are badly out of register and others are lacking in clarity. Such careless work is inexcusable in a publication of this sort—and at this price. The text description of McKay's Bunting does not agree very well with the birds figured on plate 13—strangely situated facing page 338, among the shorebirds.

Two outstanding features of the book are the gazetteer (compiled by Myra A. Putnam) and the admirable bibliographic list. The authors endeavored to "compile a bibliography of Alaskan Ornithology that would be as complete as possible." The result is 55 pages and approximately 1,010 titles, suggesting that they have at least come close to their objective. I noted only one minor discrepancy between a text reference and the corresponding title in the bibliography.

The tremendous amount of work involved in the preparation of this volume probably never can be fully appreciated by anyone but the authors, for whom the project was entirely a "labor of love" undertaken in spare hours at home for several years until more time became available. It is a major contribution to regional North American ornithology, and most of my criticisms deal with points which will not seriously limit the usefulness of the volume to ornithologists. But it is a pity that a work of this magnitude, one surely to be used by scores of workers for years to come, must be marred by inferior illustrations, and by minor errors, confusing vernacular nomenclature, and loose statements which could have been easily corrected.—Dale A. Zimmerman.

Living Birds of the World. By E. Thomas Gilliard. Doubleday and Co., Inc., Garden City, New York, 1958: 8½ × 11 in., 400 pp., approx. 400 photographs, 217 in color. $12.50.

Mr. Gilliard, of the American Museum of Natural History, and his publishers have produced a book of which they may be proud. The text is an impressive summary of the general biology of the birds of the world, reflecting the wide experience, in the field and in the literature, of the author. Equally valuable is the array of photographs—over half in color—illustrating most (but not all) of the families of birds. The photographs are mostly good, many are excellent, few are poor. To Americans, who have become accustomed to mediocre

or poor color reproductions in recent picture books on birds, Gilliard's volume provides a refreshing change. The fidelity of color and register are better, in my opinion, than in any comparable American bird book of recent years.

The book opens with a brief introductory chapter describing some accomplishments of modern ornithology. Then follows a chapter on fossil birds which, while interesting, leans to the sensational approach and fails to do justice to the known fossil record. Most of this chapter deals with Jurassic, Cretaceous, and sub-Recent birds, the entire Tertiary being disposed of in one inadequate paragraph.

Starting then on page 17 is the family-by-family account of the living birds of the world. This is the important part of the book and here Gilliard has done an outstanding job. For each family the following topics are usually treated, in a narrative fashion: distribution, number of species, general description, methods of flight and feeding, habitat, behavior, and breeding biology. In small families all species are usually mentioned by common and scientific name and briefly described, with geographic range. In larger families, well-known species, "typical" species, and unusual species are often singled out for discussion. Any book as packed with information as this one is sure to have some inconsistencies and errors. These errors and misleading statements are especially frequent in the part of the family accounts mentioning descriptive or biological particulars of various species. I have the feeling that many individual species are mentioned in a superficial attempt to give the appearance of broad coverage (and perhaps to back up the dust jacket's unjustifiable claim that "1500 species [are] described"). It would be misleading to dwell on these numerous and mostly trivial errors because for the most part the family accounts are both readable and reliable.

Major taxonomic problems at family level are usually mentioned, in lay terms, and the classification used follows Amadon's "sparrows-last" sequence for the Passeriformes, and Wetmore's classification, with some modifications, for other orders. Gilliard lists 12 subfamilies in the table of contents. Eight of them (Cochleariinae, Pedionominae, Oxyruncinae, Pseudochelidoninae, Regulinae, Hypositinae, Cyclarhinae, and Vireolaniinae) have previously been regarded by some authors as full families and are given the same treatment in text as families. The remaining four subfamilies belong to Fringillidae, and no special heading or format distinguishes them in the general discussion of the family. The subfamilies Cyclarhinae and Vireolaniinae are listed in the table of contents as subheadings after the family Nectariniidae and the accounts in text follow this family. This is confusing, to say the least, because Gilliard really considers them to be subfamilies of the Vireonidae, the next family in the sequence, as is clear on reading the text.

Many copies of this book will be sold for the pictures it contains. As already mentioned, these are of good quality. Many show behaviorisms not usually pictured. Happily, many depict birds in flight, often at a distance, and are a refreshing change from the standard short-range portrait. I notice two color photographs that are misleadingly labeled—the "Yellow-shafted Flicker" female lacks the red nuchal collar of that species; it apparently is a hybrid between that species and the Red-shafted Flicker. The "male" European Blackbird, if indeed a male, is certainly much browner even than ordinary year-old males. Some figures are poorly reproduced. In my copy these are Pygmy Nuthatch (shown as green and blue); Silver-beaked Tanager, Crested Tanager, and Blue-gray Tanager (out of register); female Pyrrhuloxia and Saffron Finch (fuzzy). For the most part, however, the figures are well chosen and faithfully reproduced. As examples, I think that the Common Tern, the Roadrunner, the Short-billed Marsh Wren, and the Painted Buntings in flight are as good as one could hope for. Illustrations are lacking for some three dozen of the 164 families recognized. Probably no photographs are available for many of these families. Surely, however, this is the most comprehensive photographic coverage of world birds yet produced. It irritates me

not to be told which pictures represent captive birds; it seems unfair to the photographers whose pictures were taken in the wild. Most of the in-captivity photographs can be identified as such by close study. Also, most of them are fairly good and probably often represent species not otherwise photographed. One notable failure, however, is the full-page black and white photograph devoted to two frazzled, cage-worn Quetzals, which scarcely live up to the text's justifiable billing of this species as "as gorgeous as a bird of paradise." The color photos by H. Ruhe and T. Roth all seem to be of captive, often disheveled, birds. North American and European birds are represented, as one would expect, by usually excellent photographs taken by several dozen skilled photographers. On the other hand, the numerous good pictures of wild birds from South America, Africa, Australia, and Asia are pleasant surprises.

All in all, Gilliard's book is one which amateur and professional bird students will find useful and authoritative.

Many persons still feel that any book costing over $5.00 is expensive. Gradually, however, it is becoming inescapably clear that *all* printing is now expensive, and colored plates especially so. Viewed this way, the price of $12.50 for this lavishly illustrated, handsomely produced book seems reasonable. There is also a British edition, printed in the United States and published by Hamish Hamilton Ltd., London, which is identical in text and plates to the Doubleday book but has a cheaper, less sturdy binding. The price of the British edition is £3 10s., or $9.80.—Harrison B. Tordoff.

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This index includes, in addition to names of species and authors, references to the following topics: behavior, food habits, fossils, hybrids, measurements, migration, molts and plumages, nesting, parasitism, physiology, populations, predation, taxonomy, voice, and weights. Also included are references of biological significance to mammals, reptiles and amphibians. Names of new forms described in this volume are printed in **boldface** type.

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LOUIS AGASSIZ FUERTES RESEARCH GRANT

This grant, established in 1947, is devoted to the encouragement and stimulation of young ornithologists. One particular desire is the development of research interests among amateur ornithologists. Any kind of ornithological research may be aided. Recipients of grants need not be associated with academic organizations. Each proposal is considered primarily on the basis of possible contributions to ornithological knowledge.

An anonymous donor gave $500 to found the fund; later donors have provided some $600. The Council of the Wilson Ornithological Society has added funds as necessary to provide at least one $100 grant annually.

Although grantees are not required to publish their studies in *The Wilson Bulletin*, it is hoped that they will submit their manuscripts to the Editor of the *Bulletin* for consideration.

Since its inception the Fuertes Research Grant has been awarded to 14 persons, many of whom have continued their research work. The recipients are listed below.

1948—Leonard R. Mewaldt, Life history of Clark's Nutcracker.
1949—Stephen W. Eaton, A comparative study of the genus *Seiurus*.
1950—Henry E. Childs, Population dynamics and life history of the Brown Towhee.
Byron E. Harrell, Ecology of the Rancho del Cielo, Tamaulipas, Mexico.
Arnold J. Petersen, Reproductive cycle in the Bank Swallow.
Harrison B. Tordoff, Comparative osteology of the subfamilies of the Fringillidae.
1951—Howard L. Cogswell, Territory size and its relation to vegetation, structure and density among birds of the chaparral.
1952—Robert W. Nero, Territorial and sexual behavior in the Red-wing.
1953—No award.
1954—William C. Dilger, The isolating mechanisms and relationships of the thrush genus *Hylocichla*.
1955—Robert G. Wolk, Analysis of reproductive behavior in the Black Skimmer.
1956—John B. Millar, An investigation of possible factors involved in the initiation of migration.
Lester L. Short, Jr., Hybridization and isolating mechanisms in North American flickers.
1957—Millicent (Mrs. Robert L.) Ficken, Comparative study of the behavior of the Canada Warbler and the Redstart.
1958—Harold D. Mahan, Studies of growth and temperature regulation in the Red-wing.
1959—No award.

Application forms may be obtained from Harvey I. Fisher, Southern Illinois University, Carbondale, Illinois. Completed applications must be received by March 1, 1960.

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